SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1907.

GENERAL PHYSICS.

1983. *Physical Conceptions of Mass.* (N. Cimento, 14. pp. 80–124, July-Aug., 1907.)—This is a discussion held by the Società Italiana di Fisica on the idea of mass in elementary teaching of physics, the first of a series of discussions as to physical concepts in their relation to elementary teaching as distinguished from the secondary instruction in which it may be assumed that the pupil already has a general knowledge of the subject. The definition of mass as quantity of matter being set aside, the discussion, broadly, was as to whether mass should be defined independently of force and force then deduced from mass and acceleration, or whether force should be defined statically and mass deduced from force and acceleration. **A. Pochettino** (pp. 107–116) gives a *résumé* of observations tending to show that mass is not entirely conserved in chemical reactions. The views of Mach, Kirchhoff, Blondlot, Appell, and others are considered. A. D.

1984. *Hertz's Formula and its Experimental Verification.* **A. N. Dinnik.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 4. Physical Part, pp. 242–249, 1906.)—From galvanometric experiments the author calculates the duration of contact in the impact of two equal spheres and, for steel spheres, finds it concordant with that deduced from Hertz's formula—

$$t = 2{\cdot}9432\mathrm{R}\sqrt[5]{[25\pi^2\delta^2(1-\sigma^2)^2/8c\mathrm{E}^2]},$$

where R is the radius of the spheres, δ the density of the material, σ Poisson's constant, E Young's modulus, and c the relative velocity at the moment of the initial contact. With zinc spheres the two results exhibit discordance, which is increased with spheres of lead. By experiments on the impact of a steel sphere on a plane steel surface, the author verifies the following general formula for the duration of contact of two unequal spheres of radii R_1 and R_2—

$$t = 2{\cdot}9432\left(\frac{25\pi^2[(1-\sigma_1^2)\mathrm{E}_1+(1-\sigma_2^2)/\mathrm{E}_2]^2(1/\mathrm{R}_1+1/\mathrm{R}_2)}{16c(1/\mathrm{R}_1^3\delta_1+1/\mathrm{R}_2^3\delta_2)^2}\right)^{1/5}.$$

T. H. P.

1985. *Potential of the Stresses in Elastic Bodies as a Measure of the Liability to Fracture.* **R. Girtler.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 509–555, March, 1907.)—Gives a mathematical investigation of the distribution of stress in, and the deformation of, an elastic cylinder under compression, (*a*) the load being uniformly distributed over the ends, (*b*) considering the effect of friction between the ends and the pressure plattens, and (*c*) taking into account the effect of eccentricity of load. The hypothesis that the potential of stress as ordinarily understood is a measure of the maximum stress at a given point (and hence of the liability to fracture) does not disagree with experimental results hitherto published—particularly Voigt's. The frictional force between the ends of the cylinder and the pressure plates, considered as the integral of the shear stress on the contact surface, is not proportional to the load, but, under certain conditions, to the stresses. The results of compression tests on glass cylinders are adduced in support of the conclusions; these tend to fracture on surfaces corresponding with the calculated surfaces of constant stress potential. F. R.

1986. *Variation of Young's Modulus under an Electric Current.* **H. Walker.** (Roy. Soc. Edinburgh, Proc. 27. pp. 343–356, 1907.)—The experiments were performed on wires, the increase of temperature above atmospheric being due to the steady current. The following values of the modulus in c.g.s. units, at the maxima and minima of the curves, indicate the kind of variation observed, the current first increasing, then diminishing, as shown by temperature :—

Soft Iron	Temperature...	20·4°	23·9	50·6	116·1	60·6	25·3	21·3
	Modulus ÷ 10^{11}	18·51	17·30	20·19	17·85	18·97	16·96	18·73
Steel	Temperature...	13·7°	15	37	108	64·2	25	15·6
	Modulus ÷ 10^{11}	21·63	21·21	21·72	21·15	21·91	20·77	21·98
Copper	Temperature...	23·8°	25·3	47·4	127	60	30	21·2
	Modulus ÷ 10^{11}	13·15	12·90	17·69	14·58	16·80	13·80	15·02
Platinum	Temperature...	20·0°	107·6	155·0	150·3	85·3	29·4	20·6
	Modulus ÷ 10^{11}	12·40	15·40	12·65	12·44	17·60	13·54	14·53

F. R.

1987. *Spherical Test-pieces of Hardened Steel.* **R. Stribeck.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1445–1451, Sept. 14; 1500–1506, Sept. 21, and pp. 1542–1547, Sept. 28, 1907.)—Although most of the experiments on which the conclusions are founded were carried out on hardened chromium steels, yet the general results will apply to hardened carbon steels. In compression tests of cylinders with enlarged ends the elastic deformation was proportional to the stress until the load greatly exceeded the elastic limit; this was observed to stresses as high as 225 tons per sq. in. The compression strength was 310 tons per sq. in., with exceptional care to obtain pure compression. Bending tests are also detailed. Hertz's formulæ for spherical contact pressure are applied to tests of spheres, between other spheres or spherical cups or flat plates. The ball form is preferred as lending itself best to uniform hardening, and Cr steel selected as it gives a very uniform hardening throughout its mass. In the formula $P/d_r^2 = f(p)$, $1/d_r = 1/d_1 + 1/d_2$; where d_1 and d_2 are the diams. of two balls pressed together with pressure P and p is the average compressive stress at the contact surface; if one of the balls is replaced by a flat plate, d_r is the diam. of the other. The results obtained are in agreement with Hertz's curve up to 39,000 kg. per cm.^{2} [$P/d_r^2 = 200$, about]. For higher values, with two equal spheres, the following results are given :—

P/d_r^2	500	1,000	2,000	3,000	4,000	6,000	8,000	12,000
p...........	48,500	57,000	66,000	71,000	74,000	78,500	81,000	84,000

For a sphere and a flat plate the values of p are slightly lower when $P/d_r^2 \geqq 2{,}000$. For a sphere between two equal spheres circular cracks appear round the contact surfaces at loads ranging from $500d^2$ to $1{,}500d^2$, and fracture occurs at from $5{,}000d^2$ to $8{,}000d^2$. This is for polished balls up to 1½ in. diam. As a measure of hardness for ordinary use the value of P for $P = 2{,}000d^2$ is recommended ; this gives a good idea of the hardness of the outer layer of the specimen. In conclusion, the author considers that the best method of hardness testing is by pressing together two equal spheres.

F. R.

1988. *Longitudinal Impact of Metal Rods with rounded ends.* **J. E. Sears.** (Cambridge Phil. Soc., Proc. 14. pp. 257–286, Oct. 15, 1907.)—B. Hopkinson found [Abstract No. 928 (1905)] that the momentary extension in a copper wire under a blow was about 5 per cent. higher than expected from the modulus of elasticity under static load. The author, in experiments in which equal rods with rounded ends strike one another longitudinally, finds that the observed and calculated velocities agree with one another within 0·5 per cent. for steel, iron, copper, and aluminium. The observed values of the wave-velocities, and those calculated from the results of static tests and, in the case of the adiabatic velocities, corrected using published values of the coefficients of expansion and the specific heats at constant pressure, are shown in the following table, in ft. sec. units :—

	Observed Velocity.	Calculated Velocity.	
		Isothermal.	Adiabatic.
Steel	16,820	16,750	16,770
Copper	12,060	12,010	12,080
Aluminium	16,620	16,580	16,620

F. R.

1989. *Cause of Failure of a Tail Shaft.* **P. D. C. Kley.** (Dingler's Polytechn. Journ. 43. pp. 683–685, Oct. 26, 1907. From De Inginieur, pp. 627–688, 1907.)—The tail shaft of ss. *Goenloer* broke after three years' service. Although the tensile tests of the broken shaft were fairly satisfactory, yet the structure indicated faulty treatment. This was confirmed by the following results of alternating bending tests (Wöhler method) :—

A normal shaft (0·4 per cent. carbon) stood before rupture	54,000 reversals of stress.
A piece of the broken shaft, without further treatment, stood before rupture	24,750 „ „
A piece of the broken shaft, after annealing 1 hour at 800° C.	45,000 „ „

F. R.

1990. *Fall of a Sphere and of a Cylinder in a Viscous Liquid.* **G. Picciati.** (Accad. Lincei, Atti, 16. pp. 943–951, June 16, and pp. 45–50, July 7, 1907.)—Takes up the problem of a falling sphere from Bassett's "Hydrodynamics," and obtains a complete integration of the functional equation. The method is practically that used in the propagation of heat, employing the theorems of Dirichlet and Hôpital. The final result is Stokes's equation—

$$V = (2a^2/9k)(\eta - \rho)g,$$

where a is the radius, k the viscosity, ρ the density of the liquid, and η that of the sphere. (Ibid. 16. pp. 174–184, Aug. 4, 1907.)—Contrary to the case of a sphere, an infinite rod moving at right angles to its own axis in an infinite viscous liquid does not acquire a definite velocity. There is no distance at which the velocity of the liquid itself becomes infinitesimal. By integration to infinite distance, the author proves that eventually the velocity of infinitely remote particles of the liquid becomes the same as that of the rod itself. The whole liquid then moves as if it formed one body with the rod.

E. E. F.

1991. *Displacement of the Gravitation Anomalies.* **G. Costanzi.** (Comptes Rendus, 145. pp. 695–697, Oct. 21, 1907.)—According to Defforges, gravitation is too strong above the seas and too weak above the continents. Many observations are not in agreement with this rule, however, notably those of Nansen on the Arctic Sea and ice, of Riccò in Calabria and Hungary, of Hecker on the Atlantic and Pacific, of Gurgo and the author in Central Europe and Japan. According to the author, the absolute maxima of the negative anomalies are not along the main axis of a mountain chain, but along a line parallel to it and opposite the greatest neighbouring depression; the maxima of the positive anomalies are not above the depressions, but are displaced towards those anomalies; the direction of the displacement is approximately that of the normal on the external side of the curved mountain chains. The only exception to the first of these three rules is Etna, on which the maximum negative anomaly occurs at the summit. The observed irregularities suggest that there is general movement of the ground and a movement of the lower strata of the earth relative to the upper; the upper strata lag behind the lower. The displacement is to the north in the case of the Alps, Eastern Carpathians, and Northern Apennines, in accordance with the views of Suess and of Bertrand.

H. B.

1992. *Absolute Determination of the Nocturnal Radiation at Vienna.* **J. Krĕmář** and **R. Schneider.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 571–600, March, 1907.)—The measurements were made at the Zentralanstalt für Meteorologie, 202 m. above sea-level, 26 m. above ground, 2 m. above the platform, in Aug. and Sept., 1906, with two Ångström electric compensation actinometers. For five nights readings were taken every 15 min., commencing at 8 p.m., that is, about an hour after sunset. The loss by radiation is very rapid at first, attains its maximum between 9 and 10 p.m., becomes slower then, with a faint secondary maximum at 2 p.m., and continues slow until about ¾ hour before sunrise, when the loss is again rapid. With falling air temperature the loss by radiation becomes less marked. The mean loss per min. per cm.^{2} was 0·158 gm.-cal.; this figure is of the same order as those of Maurer, Pernter (on Sonnblick at 3,095 m., 0·201 cal.), Trabert, Exner (again on Sonnblick, 0·19 cal.), while Homén observed much lower values in Southern Finland (0·067 and 0·084 cal.). By reflex radiation from the non-luminous atmosphere the ground in Sept. gained 0·37 cal. per cm.^{2} per min. The total radiation received from the sun during the three first Sept. days—as regularly measured by the pyrheliometer at Vienna—was 318, 321, 311 cals., or, allowing for diffusion losses of 40 per cent. according to Trabert, 445, 449, 435 cals. Assuming the same rate of loss by radiation for the day as determined for the night, the heat gain per cm.^{2} would have been on those three days + 215, 228, 225 gm.-cals. per cm.^{2}, mean value 223 gm.-cals. per day. H. B.

1993. *Solar Radiation.* **A. Bemporad.** (Accad. Lincei, Atti, 16. pp. 66–71, July 7, and pp. 126–132, July 21, 1907.)—The three formulæ (1) Pouillet's, $q = A_1 p^e$; (2) Crova's, $q = A_2(1 + e)^{-n}$; and (3) Bartoli's, $q = A_3 c^{-m}$, where q is the intensity of sunshine and e the corresponding thickness of the atmosphere, tend to break down as the sun nears the horizon. The author suggests $q = Ap^{e^n}$, or $\log q = a - be^{n}$, where n is between 0·5 and 0·9, but is mostly about 0·7. It can be ascertained from three observations of q at zenithal distances differing considerably from one another, which lead to the equation—

$$\frac{e_1^n - e_2^n}{e_2^n - e_3^n} = \frac{\log q_1 - \log q_2}{\log q_2 - \log q_3},$$

which can be solved by approximation. Tables of values of e^n for different zenithal distances and values of n are given. Applications follow of the new formula to observations by the author at Catania and by Ångström at Teneriffe. A. D.

1994. *Thunderstorms, "False Cirrus," and Halos.* **C. Kassner.** (Meteorolog. Zeitschr. pp. 301–306, July, 1907. Science, 26. p. 518, Oct. 18, 1907. Abstract.)—The veil of cirrus cloud observed before and after thunderstorms is generally designated a "false cirrus"; according to W. v. Bezold and Hann it would probably be a true cirrus. The author has studied the literature on the subject, but finds that too little attention has been paid to halos. He therefore examines the records of Bremen (1892 to 1905), Potsdam, Hoppendorf near Danzig, Upsala, and Sofia for observation of thunderstorms and solar halos on the same day, and comes to the following conclusions: Solar halos observed before and after thunderstorms show that the cirrus veil of thunderstorms is an ice cloud, and that it therefore represents a true cirrus. The veil may precede a storm by up to four hours and still be visible an hour after the thunderstorm; during these five hours the veil would, at an average velocity of 40 km., travel 200 km., which figure is a measure of the extent of the cloud. H. B.

1995. *Upper Air Research in Egypt.* **B. F. E. Keeling.** (Nature, 76. p. 637, Oct. 24, 1907.)—The Helwan Observatory (under the Survey Department of Egypt) sent up 15 pilot balloons in Aug., of which three reached an altitude of 5,000 m., the others bursting at lower levels. The balloons are inflated with dry hydrogen (from zinc and sulphuric acid) to a diam. of 2 ft., and are watched with the aid of theodolites (from Bosch, Strassburg) at the ends of a base line of 1 km. length. In the diagram reproduced the order of the winds from the surface upwards was from S.W., N.W., S.W. As a rule the surface winds seem to blow from N. or N.W., while at 1,000 or 2,000 m. winds from W. or W.S.W. set in, replaced by other winds above 4,000 m. Kite experiments, with regard to which reference is made to W. H. Dines and J. E. Petavel, were to be commenced. H. B.

1996. *Influence of Forests upon Wind Velocity.* **I. St. Murat.** (Science, 26. p. 518, Oct. 18, 1907. From the Annales of the Roumanian Academy, Bucharest.)—A forest diminishes the wind velocity to the leeward of the forest. At 50 m. distance this diminution may amount to one degree on the Beaufort scale. When the distance exceeds 100 m. the wind force becomes more noticeable again, and at 500 m. the full original force is encountered. H. B.

1997. *Density of Sea-water by a Differential Densimeter.* **J. J. Manley.** (Roy. Soc. Edinburgh, Proc. 27. pp. 210–232, 1907.)—The densimeter known as Hare's apparatus embodies the principle elaborated in the six or seven forms constructed and tested. In one of the forms two glass tubes are used, each having an internal diam. of about 8 mm. and a length of 1,200 mm. These tubes are provided with obliquely perforated taps, and are sealed at their upper ends to small bulbs, the water rising to between the tap and the bulb. The upper ends of the bulbs are joined by an inverted U-tube, into the bend of which a three-way tap is sealed; one of the two free branches of this tap communicates with an exhausted copper globe with a capacity of 4·2 litres. The level of the liquids is observed by a micrometer microscope, and, to secure uniformity of temperature, the tubes are brought together throughout their entire length and surrounded by a water-jacket. A standard sea-water of known density takes the place of distilled water in one of the tubes, and, the levels of the cisterns being made the same, only two readings are taken, the two lower taps being closed during reading. The densities of ninety different waters from the Mediterranean are measured, these varying between 1·0274 and 1·0818 at 18° C. G. E. A.

1998. *Electrical Conductivity and Refracting Power of Sea-water.* **E. G. Hill.** (Roy. Soc. Edinburgh, Proc. 27. pp. 233–243, 1907.)—The samples of water were from the same source as those mentioned in the preceding Abstract. The conductivity was determined by Kohlrausch's method, the water being kept in a thermostat while under observation. A refractometer was employed with a hollow prism of about 60° for the optical measurements, and a table is given of the measurements for ninety different waters. From a comparison of the results it is seen that neither the densities, conductivities, nor refractive indices give values which vary exactly with the chlorine values of the waters, this being contrary to Knudsen's conclusion that the conductivity of a sea-water may be taken as a measure of its salinity. But the difference between the value for chlorine calculated from the physical constants and that measured by titration is sometimes so small that for purposes of oceanography it may be assumed that the two values are identical. G. E. A.

1999. *Dynamical Theory of the Earth's Figure.* **A. E. H. Love.** (Nature, 76. pp. 327–332, Aug. 1, 1907. Paper read before the British Assoc. at Leicester. Engineering, 84. pp. 259–260, and 262, Aug. 23, 1907. Science, 26. pp. 529–541, Oct. 25, 1907.)—The paper deals with the problem of determining the shape of the earth supposing the oceans were all dried up. From maps showing ocean depths it can be calculated that if the sea were lowered about 1,400 fathoms then the areas of land and water would be of approximately equal extent. By going lower for the dividing line a state is reached where we have a continuous continental region and two oceanic regions, and the key to the problem of this peculiar distribution is given by the theory of Jeans on gravitational instability. The applications of spherical harmonics of the third degree is then discussed, and the resulting conformation of the surface giving equal areas of elevation and depression is illustrated by a diagram, which is remarkably similar to the curve mentioned above as showing the configuration at a certain depth below present sea-level. Thus, as regards the contour of the great ocean basins, we seem to be justified in saying that the earth is approximately an oblate spheroid, but more nearly an ellipsoid with three unequal axes, having its surface furrowed according to the formula for a certain spherical harmonic of the third degree, and displaced, relatively to the geoid, towards the direction of the Crimea. With regard to the actual amount of elevation or depression in different parts the agreement of the theory with the facts is not quite so good. It is probable that the earth is not now gravitationally unstable. From observations of the propagation of earthquake shocks to great distances we can determine the average resistance to compression, and it is found that this is sufficient to check any tendency to gravitational instability. As bearing on geological evidence it is interesting to note that in parts of the Southern Pacific a depression represented by harmonics of the third degree is superposed upon an elevation represented by second degree harmonics, and we should therefore expect to find the depth of the ocean to be gradually increasing in this region. The region in question is that of the coral reefs and coral islands, such as Funafuti, and the result is thus quite in accord with Darwin's theory of the formation of coral reefs. Other parts of the discussion show the agreement with theory of the different types of coast-line found on either side of the two great ocean tracts. C. P. B.

2000. *Figure of the Earth.* **J. Prescott.** (Phil. Mag. 14. pp. 482–498, Oct., 1907.)—The shape of the earth is assumed to be an oblate spheroid of small ellipticity, which it is the object of the paper to determine. The author concludes that the most probable value of the eccentricity at the surface is 1/308, the densities at surface and centre being respectively of the orders 3 and 30, giving a mean density 5·5. At the other extreme of the estimate occur the values 1/299, 2·5, and 10, which again yield a mean density of 5·5. E. H. B.

2001. *Progress of Astronomical Knowledge.* **D. Gill.** (Nature, 76. pp. 319–327, Aug. 1, 1907. Presidential Address to the British Assoc. at Leicester. Chem. News, 96. pp. 49–55, Aug 2, and pp. 61–63, Aug. 9, 1907. Science, 26. pp. 193–212, Aug. 16, 1907.)—The author deals with astronomical progress along various lines. Improvements in the measurements of standards have been possible in consequence of Fabry and Perot's investigations on interferential measurements, and for practical measurements in the field the nickel steel alloys have provided special wires, which for considerable periods of time may be considered as almost invariable standards. The great South African arc of meridian has been completed from Cape L'Agulhas to within 50 miles of the southern end of Lake Tanganyika, *i.e.*, a continuous geodetic survey extending over 25 degrees of latitude. It is understood that the carrying of the arc round the eastern shores of Tanganyika is contemplated by the German authorities, and from thence the work will be carried up to Alexandria by the Egyptian Survey. From here it would then be possible to continue round Asia Minor to Greece, connecting up with Struve's great arc which terminates at the North Cape. If realised this would constitute an arc of meridian 105° in length—the longest possible on the earth's surface. *The Solar Parallax* has been determined with great accuracy from observations of the minor planets Iris, Victoria, and Sappho, and more recently Eros. In 1931 there will be a specially favourable opposition of Eros, when it approaches the earth within one-sixth part of the sun's mean distance, and by this means it should be possible to determine the solar parallax within one-thousandth part of its amount. Other parts of the address deal with the constitution of the universe, stellar parallax, the sun's velocity in space, and the distribution of stars in space. C. P. B.

2002. *Theory of Solar Disc.* **H. Bourget.** (Comptes Rendus, 145. pp. 301–302, July 29, 1907.)—Shows that the theory of the propagation of light in a heterogeneous medium gives no polarisation, and that Fabry's proof of the absence of reflection is unnecessary for supporting Julius's theory of the sun's disc, and answering Salet's objection to it. Boussinesq has already shown that a parallel beam traversing plane strata retains its parallelism and its original state of polarisation. Curved pencils of light will therefore show no polarisation due to their curvature. E. E. F.

2003. *Temperature of Sun-spots.* **A. L. Cortie.** (Astrophys. Journ. 26. pp. 123–127, Sept., 1907.)—Band spectra have been observed in sun-spots at various times since Secchi's first attempt in 1869, and their subsequent identification as flutings is indicative of the presence of chemical compounds as distinct from elements in the spot region. Bands at the extreme red have been identified by Hale and Adams as produced by titanium oxide, and quite recently Fowler has ascribed the bands near *b* in the green to magnesium hydride. Reasoning now from this knowledge of sun-spot spectra, we find that the bands in the spectra of α Hercules and o Ceti were shown by Fowler to be due to titanium oxide, and this compound has been further recognised in α Orionis. Mira Ceti has been observed at two maxima of very different intensities. In Dec., 1906, at a magnitude of 2·0, it was 2½ times brighter than at the maximum of 1897, and we find a definite change in the spectrum. The band spectrum was of the same structure in the two cases, but very much weaker in 1906, when the star was most brilliant. Variations in the intensities of the hydrogen lines are also prominent, of a similar nature to the changes observed in new stars. We see therefore that as the brightness and temperature of a star increases, the band spectrum is gradually changed to a line spectrum; and the discussion of this with relation to sun-spots points to the conclusion that the temperature of spot vapours is lower than that of the solar photosphere. C. P. B.

2004. *Red Spot on Jupiter.* **S. Williams.** (Astronom. Nachr., No. 4202. p. 23, Sept. 30, 1907. Nature, 76. p. 625, Oct. 17, 1907.)—Observations of the Great Red Spot during the recent opposition. The spot was about as faint as before, and the rotation period from 594 rotations is 9h. 55m. 42·27s. Its longitude is 20·87° ± 0·28°. As indicating a real change in the position of the spot, attention is drawn to the variation of the rotation period between 1905 and 1907 [see Abstract No. 616 (1907).]. C. P. B.

2005. *Markings on Third Satellite of Jupiter.* **J. C. Solà.** (Astronom. Nachr., No. 4199. p. 881, Sept. 6, 1907. Nature, 76. p. 527, Sept. 19, 1907.)—Description of markings, with their position angles at stated times. (1) Visibility of Northern White Cap is independent of the satellite's position with regard to the planet, and is much greater than that of the other cap; its brightness is comparable to the polar caps of Mars. (2) This Northern Cap is always bordered by a dark area. A plate of twelve drawings accompanies the paper, showing the variations during the period 1906, Nov. 24 to 1907, March 25. C. P. B.

2006. *Theory of Jupiter's Satellites.* **W. de Sitter.** (Konink. Akad. Wetensch. Amsterdam, Versl. 16. pp. 110–122, July 17, 1907. Proc., 10. pp. 95–107, Sept. 3, 1907.)—A new investigation of the theory of the libration of the satellites of Jupiter, and of the equations of the centre. The libration probably has an appreciable coefficient; the determination from the observations, not only of the phase and amplitude, but also of the period of the libration, is important for the determination of the masses, especially for Satellite I., and it is possible that this determination can be made from a discussion of the observations made at the Cape, Helsingfors, and Pulkowa. The author finds a different period from that given by Laplace and Souillart. C. P. B.

2007. *Double Drift Theory of Stellar Motions.* **E. H. L. Schwarz.** (Nature, 76. p. 588, Oct. 10, 1907.)—Discussing the planetismal hypothesis outlined by J. C. Chamberlin, according to which our stellar system is a disc the edge of which is the Milky Way, beyond this lying another stellar system seen as the Andromeda Nebula, the writer examines the bearing of this idea on the recent work on double star drifts. If our stellar system is of the same nature as the Andromeda nebula, then it must be a spiral nebula with two equivalent arms originating from a central core, and winding spirally round the centre in approximately the same plane. Supposing, then, our sun had experienced a gravitational drag, and was moving at a less rate than the general average of the other stars, or suppose its spiral course was steeper than the general average, and hence its angular velocity less, then an observer regarding the rest of our stellar system from our planet would see the stars near the centre of the spiral travelling in two directions, those on this side of the centre travelling from right to left, and those on the other side in the reverse direction. C. P. B.

2008. *Spectrum of Comet* 1907*d* (*Daniel*). **H. Chrétien.** (Comptes Rendus, 145. pp. 549–551, Sept. 23, 1907.)—From a series of spectrograms obtained at the Nice Observatory with a prismatic camera on the evenings of July 9, Aug. 5, 12, 13, 16, 17, the author gives a discussion of the origins of the bands obtained. The prism had a refracting angle of 62°, adjusted at minimum deviation for G (λ4341), and the camera objective had an aperture of 10 cm. and a focal length of 47 cm. The edge of the prism was placed in the direction of the diurnal motion, which was almost coincident with that of the tail of the comet. For comparison purposes the spectrum of Capella was photographed on the same plate. The bands found were at the wave-lengths: 3870, 3989, 4012, 4111, 4200, 4258, 4301, and 4503. The principal bands in the spectrum of the tail were 4016, 4267, and 4522. C. P. B.

2009. *Spectrum of Comet* 1907*d* (*Daniel*). **F. Quénisset.** (Soc. Astronom. de France, Bull. p. 385, Sept., 1907. Nature, 76. pp. 526–527, Sept. 19, 1907.)—Photographic reproductions of the comet, showing that the tail had a distinctly multiple structure, and extended some 8°–10°. Between July 12 and Aug. 15, twenty-six photographs were obtained, some indicating a rotary motion of the cometary matter. The spectrum showed three strong hydrocarbon bands, superposed on a brilliant background of continuous spectrum. These bands were sharply defined on the red side and faded away gradually towards the violet. The green band was brightest, then the blue, and the orange band was faintest. **H. Rosenberg.** (Nature, 76. p. 555, Sept. 26, 1907.)—Photographs taken with a Zeiss prismatic camera at the Göttingen Observatory on Aug. 9, 11, 14. Spectrum shows the chief hydrocarbon bands and a continuous spectrum extending from λ5050 to λ3700. The brightest bands are those of cyanogen at λ3883 and λ3872, while the third strongest band is at λ4737. Two bands at λ4055 and λ4035 are as yet unidentified. [See also Abstract No. 1803 (1907).] C. P. B.

2010. *Spectrum of Comet* 1907*d* (*Daniel*). **J. Bosler.** (Comptes Rendus, 145. pp. 582–583, Oct. 7, 1907.)—The spectrum of the comet was observed at Meudon with a two-prism spectrograph. The apparatus receives the light from a 4-inch, objective ; the final aperture ratio is 1/4·4. The entire spectrograph revolves about the optic axis of the collimator, so that the slit can be set parallel to the tail of the comet. Three photographs were obtained on Aug. 8, 18, 19, with exposures, respectively, of 40 min., 1 hour, and 1 hour 10 min. (plates Lumière "Σ"). Two comparison spectra of iron with condenser and self-induction were taken on each plate. The photographs show the ordinary spectrum of the hydrocarbons with a maximum of intensity near λ469, the bands in general not being sharply defined towards the red, as usual. In addition, two cyanogen bands are well indicated, and some other radiations of uncertain origin. These remarks apply only to the nucleus and head, the tail properly so called having left no traces. A list is given of the wave-lengths and intensities of 16 lines measured on the photographs. The cyanogen bands are fainter than the blue hydrocarbon bands, while the contrary is the case on the plates obtained simultaneously by Deslandres and Bernard with an objective prism [Abstract No. 1803 (1907)]. The cyanogen bands are, however, much longer than the others on the author's plates. The differences are attributed to the yellow tinge, and their consequent opacity to the more refrangible rays, of the prisms employed by the author. The same defect accounts for the failure of impression of the tail. A. E.

2011. *Physical Nature of Meteor Trains.* **C. C. Trowbridge.** (Astrophys. Journ. 26. pp. 95–116, Sept., 1907.)—Meteor trains are the luminous clouds formed by meteors which persist long after the incandescent nucleus has disappeared. The average of the heights above the earth's surface of the middle portion of the trains is 54 miles (87 km.), the minimum being about 45 miles, and the maximum 65 miles. It would thus appear that in the zone between 50 and 60 miles' altitude there exist the special atmospheric conditions necessary for the production of these phenomena. That the appearance is due to gaseous phosphorescence is probable (1) because of the rapid lateral expansion of the train, evidently a gas diffusion, amounting to a mean rate of over 100 metres per min. ; (2) on account of the great volume contained within the boundary of the train, usually amounting to many cubic miles; (3) because the observed spectrum consists of bright lines. Further, the rate of decay of the glow corresponds to values found in the laboratory for the electrodeless ring discharge in gases. The dual appearance of the trains is ascribed to their tubular nature, giving increased intensity at the two edges in the line of sight. C. P. B.

REFERENCES.

2012. *The Reversible Pendulum.* **J. C. Shedd** and **J. A. Birchby.** (Phys. Rev. 25. pp. 274–293, Oct., 1907. Paper read before Joint Meeting of the Amer. Physical Soc. and the Amer. Assoc. for Advancement of Science, Dec. 29, 1906.)—The present paper (Part I.) deals theoretically with the reversible pendulum both analytically and graphically, the various quantities involved being considered in pairs as the variables of the problem. E. H. B.

2013. *Bending of Curved Beams.* **C. Pfleiderer.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1507–1511, Sept. 21, 1907.)—Extends the calculations referred to in Abstract No. 602 (1907) to beams of any uniform section, and works out in particular the cases of elliptical and trapezoidal sections, from which circular, equilateral triangular, and rectangular sections are readily obtained. F. R.

2014. *Report of the Reichsanstalt for* 1906. (Engineering, 84. pp. 468–469, Oct. 4, and pp. 498–500, Oct. 11, 1907.)—A fairly full translation of the chief points dealt with in the Report. [See Abstract No. 1283 (1907).]

2015. *Theory of Surface Forces.* **G. Bakker.** (Phil. Mag. 14. pp. 509–528, Oct., 1907.)—A continuation of the work dealt with in Abstract No. 209 (1907).

2016. *Progressive and Stationary Waves in Rivers.* **V. Cornish.** (Engineering, 84. pp. 118–119, uly 26; 284–286, Aug. 23, and pp. 347–349, Sept. 6, 1907.)—Gives photographs and data from many sources. Unsuitable for abstracting. L. H. W.

2017. *Occurrence of Rare Earths in the Sun.* **G. Hofbauer.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 267–313, Feb., 1907. From the II. physikal. Inst. d. Univ., Wien.)—Examination of the wave-lengths of many of the lines originally left without any terrestrial identification. A table is given of solar lines between λ2977·021 and λ4744·008, showing the probable origin of the lines which may be due to rare earths. C. P. B.

2018. *Perth Catalogue of Standard Stars.* **W. E. Cooke.** (Pp. 1–13, Perth, W. Australia, 1907. Summary of explanatory note in Nature, 76. p. 581, Oct. 3, 1907.)

2019. *Submerged Tubes.* **C. B. Stewart.** (Eng. Record, 56. pp. 352–354, Sept. 28, 1907.)—This paper gives a description of experiments with submerged tubes 4 ft. square to determine the effect (1) of change in the length of the tube, and also (2) of modification of the entrance conditions on the loss of head and the coefficient of discharge. The research is being continued. A. W.

2020. *Liquids under Centrifugal Force.* **Van der Mensbrugghe.** (Annal. Soc. Sci. de Bruxelles, 31. 3. pp. 272–282, 1906–1907.)—Deals with the rupture of a thread of mercury in a rotating tube, and discusses the steady state of liquids in a rotating sphere. E. H. B.

LIGHT.

2021. *Selenium Photometer.* **J. J. Taudin Chabot.** (Phil. Mag. 14. p. 428, Sept., 1907.)—A selenium resistance is illuminated in rapid alternation with light from the two sources to be compared. Fluctuations take place in the current traversing the selenium cell except when the illuminations due to the two sources are equal. The author uses a slotted rotating disc and an Einthoven string galvanometer, which shows by its vibrations when the illuminations are unequal. Exceptional sensitiveness is attained by making the frequency of the alternate illuminations correspond to the natural vibration of the galvanometer string. E. E. F.

2022. *Improvements in the Ultra-violet Microscope.* **W. T. Swingle** and **L. J. Briggs.** (Science, 26. pp. 180–183, Aug. 9, 1907.)—Good, sharp images were obtained in the microscope by using strictly monochromatic visible light. A double electrode-holder was, therefore, constructed by means of which blue light from magnesium is employed first for finding and focussing the object. A handle then serves to replace the magnesium poles by a pair of cadmium ones, which provide the photographic rays, a certain amount of focussing having to be done for each objective used. G. E. A.

2023. *Change in Polarisation Azimuth due to Earth's Motion.* **B. Strasser.** (Ann. d. Physik, 24. 1. pp. 137–144, Oct. 8, 1907. Physikal. Inst. d. techn. Hochschule, Danzig-Langfuhr.)—Describes an elaborate arrangement by which the author has repeated Fizeau's experiment on the change in polarisation azimuth of a refracted ray due to the motion of the earth. With rotations of 58° in the west and east directions the mean excess of the rotations in one direction over those in the other was 0°·03. Another set of experiments with rotations of the order 61° showed a *maximum* excess of 0°·018, and a *mean* excess of 0°·0012 only. The author accordingly concludes that the effect in question has not yet been detected. E. H. B.

2024. *Diffraction and Reflection on Maxwell's Theory.* **W. v. Ignatowsky.** (Ann. d. Physik, 23. 5. pp. 875–904, Sept. 24, 1907.)—This highly analytical paper treats diffraction and reflection on the basis of Maxwell's electromagnetic equations and deals specially with diffraction at a wire. For this case numerical values are calculated, curves plotted, and a comparison with experiment made, the theory and observation being in good agreement. The curves show not only faint equidistant maxima and minima inside the geometrical shadow, but also faint graduated maxima and minima outside the geometrical shadow, and superposed upon the main diffraction bands which occur there. E. H. B.

2025. *Lloyd's Bands for Internal Reflection and Phase-change.* **P. V. Bevan.** (Phil. Mag. 14. pp. 503–508, Oct., 1907.)—Describes and illustrates by photographs Lloyd's fringes for internal reflection obtained in water, the level upper surface of which formed a large perfectly plane mirror, the meniscus at the sides of the trough giving no trouble, as the surface there turns upwards out of the way. It was found that the centre of the system is a dark fringe, just as with a single mirror of black glass, so that in each case there is the loss of half a wave on reflection at grazing incidence. This result is discussed in the light of the Fresnel-Stokes formulæ, and held to be in agreement with them. E. H. B.

2026. *Optical Behaviour of Colloidal Metals.* **E. Müller.** (Ann. d. Physik, 24. 1. pp. 1–24, Oct. 8, 1907. Physikal. Inst. d. Univ., Heidelberg, June 24, 1907.) —A research on the absorption and polarisation of light by colloidal metal solutions. The case in which the colloidal particles are considered as small conducting spheres has been calculated by J. J. Thomson, and his theory was extended by Ehrenhaft [Abstract No. 107 (1906)]. Measurements of the polarisation of light scattered by metallic particles have been made by Threlfall (Phil. Mag. 1894) and Ehrenhaft [Abstract No. 61 (1904)], the observations of the latter confirming Thomson's theory completely. The author's experiments were made on solutions of Au, Pt, and Ag, obtained by Bredig's method, and his results are as follows: Colloidal solutions are distinguished from turbid ones, the particles of the latter being insulators. Whilst in the second kind of solution the rays of scattered light with maximum polarisation were at an angle of less than 90° to the incident beam, this maximum was below 125° for freshly prepared Au solutions, below 112° for Pt, and below 97°·5 for Ag. The colour of the metal solutions in transmitted light is due partly to the scattering of the light and in part to the colour possessed by the solution itself. The ageing of the solutions, or the addition of a trace of acid, causes a change of colour and, simultaneously with this, a motion of the polarisation maximum to below 90°. At the same time the polarisation increases very strongly in Au and Pt, but decreases in Ag. The addition of a trace of gelatine prevents change of colour and precipitation of the metal, but has no influence on the change of polarisation. The above results do not uphold any explanation of the optical properties of colloidal metals based solely on the size of the particles. G. E. A.

2027. *Pleochroism in Metallic Mirrors.* **H. Ambronn.** (Phys. Zeitschr. 8. pp. 665–668, Oct. 15, 1907.)—After giving some historical notes on pleochroism, experiments are described in which silver is deposited on celluloid, and the celluloid deformed by slow stretching. Pleochroism appeared with a stretch of 20 per cent., the silver film having a yellowish colour in the polarisation microscope employed when the plane of the nicols was parallel to the direction of stretching, and bluish when the nicols were turned through 90°. Gold deposited on glass exhibits pleochroism after the glass has been softened in a flame and stretched, and similar results were obtained with silver deposited on glass. Siedentopf has found that cubes of rock-salt, coloured by kathode rays, become pleochroitic with a deformation of 10 to 20 per cent. The cause of this effect in metallic films is probably to be found in the uniform orientation of the particles forming the films. G. E. A.

2028. *The Psychophysical Law.* **C. Henry.** (Comptes Rendus, 145. pp. 638–641, Oct. 14, 1907.)—If i denote luminous intensity then the relative variation of the intensity may be denoted by di/i. The researches of König and Brodhun on the way in which di/i varies as i increases are discussed. The results show that Fechner's modified logarithmic law is only a rough approximation. The author quotes empirical equations giving di/i as a function of i both for white light and for monochromatic lights of wave-lengths 575, 605, and 670 $\mu\mu$ respectively. For low values of the intensity the electric energy of the current in the optic nerve is nearly proportional to the apparent intensity of the illumination. The luminous intensity is measured by the visual acuity which is produced by the excitation of certain elements of the *fovea*. In comparing luminous intensities with a photometer we do not measure the intensity i directly, but the intensities i_1 and i_2 between which it lies. Assuming Fechner's law $i = \sqrt{i_1 i_2}$, in photometers founded on the inverse square law we have $i_1 = kd_1^2$ and $i_2 = kd_2^2$ and thus $i = kd_1d_2$; if we take, as is customarily done, for i the mean value $k[(d_1+d_2)/2]^2$ the error is $-k[(d_1-d_2)/2]^2$, a result which is easy to interpret. Owing to this psychophysical error, which is very appreciable at low and high intensities, the author considers it advisable to take as the photometric variables both a rigorously objective element, for example, the energy of the ray, and a subjective element like the areas of S (a physiological unit) corresponding to different values of λ. This method would permit the determination of the normal physiological values of luminous sources, which are the important values in practice. A. R.

2029. *The Cosine Flicker Photometer.* **J. S. Dow.** (Phil. Mag. 14. pp. 644–658, Nov., 1907. Paper read before the Physical Soc., June 28, 1907.) —The two sides of a rectangular Ritchie wedge are illuminated by the two sources. Above it a 45° mirror is placed so that the observer sees a reflected image of the illuminated surface. The wedge can rotate about the line of intersection of the photometrical surfaces. To obtain a balance the wedge is rotated through an angle θ and in this case $I_1/I_2 = \cos(\alpha-\theta)/\cos(\alpha+\theta)$, where α is the angle between the two surfaces. In the instrument α is 45°, and the author shows that it can be made direct-reading with a good scale between 0·2 and 5·0. The instrument can be utilised either on the "equality of brightness" or the "flicker" principle. In the latter case an oscillating lens driven by an electric motor is used. The author has found that for widely differing colours and for certain portions of the retina the results obtained by the two methods do not agree. When comparing lights of different colours the flicker method gives rise to the most consistent results. It is shown how the sensitiveness of this type of photometer can be increased by introducing the principle of contrast. Crova's method of comparing only the rays for which $\lambda = 0{\cdot}582\,\mu$ from the two sources was examined experimentally. In most cases the means of a set of photometrical results obtained with and without the Crova screen agreed very closely. The unsteady nature of the light from the arc renders very exact measurements impossible, but even in these cases the maximum difference is less than 5 per cent. The author's experiments, however, prove that the use of yellow screens to facilitate the photometric comparison of heterochromatic sources of light is only justified in the case of illuminants giving continuous spectra. A. R.

2030. *Newton's Rings in Polarised Light.* **C. V. Raman.** (Nature, 76. p. 687, Oct. 24, 1907.)—Reference is made to an error occurring in some text-books where it is stated that when Newton's rings are seen between two lenses of the same substance, by light polarised perpendicularly to the plane of incidence, reflected at an angle greater than the polarising angle of the substance, the centre of the rings is bright. This is not the case; the centre of the rings is black under these conditions, as has been shown by Stokes from the principle of reversibility and also proved by experiment. J. J. S.

2031. *Interference Phenomena of Plane-parallel Plates with a Continuous Spectrum.* **E. Gehrcke** and **O. Reichenheim.** (Ann. d. Physik, 23. 4. pp. 745–757, Aug. 22, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The apparatus consists of a plane-parallel plate set between the source of light and the slit of a high-dispersion spectroscope. The plane-parallel plate is mounted on three screws and set in the first place parallel to the slit. It is then turned slowly though a small angle until the best definition of the fringes is obtained. The authors suggest the use of this apparatus to check the measurements of Fabry and Perot. [See Abstract No. 1870 (1906).] E. C. C. B.

2032. *Spectroscopes with Mirrors.* **M. Hamy.** (Comptes Rendus, 145. pp. 590–591, Oct. 7, 1907.)—The author calculates the relative position of the mirror and prism or grating in spectroscopes in which a spherical concave mirror is substituted for the telescope lens. The last prism-face or grating should not be put at the centre of curvature of the mirror, for in this case the field is not flat; the best position is at a distance of R/2—0·154F, where R is the radius of curvature and F the local length. In this case the field is flat, and, further, the instrument is astigmatic. E. C. C. B.

2033. *The Shifting of Spectrum Lines.* **F. Exner** and **E. Haschek.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 823–841, Feb., 1907.)—In a previous paper [Abstract No. 52 (1907)] the variability in the position of certain spectrum lines was dealt with and in the present paper the authors enter fully into the question. They have investigated with a small echelon grating the structure and the distribution of intensity in certain lines in the spectra of Li, Ca, Cu, Zn, Sr, Ag, Cd, Sn, Ba, and Bi. They find undoubted evidence of variations both in the number and in the relative intensity of the satellites in these cases and also in the relative intensity of the principal line and the satellites. The variations are produced by slight alterations in the current passing in the arc and in the density of the vapour of the element in question. The result of these variations is that with a spectroscope of smaller resolving power, *e.g.*, a grating, the position of the whole line appears to shift. The authors point out the importance of this upon spectroscopic work. E. C. C. B.

2034. *Two-fold Line Spectra of Chemical Elements.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 9. 16. pp. 321–332, Aug. 30, 1907. Phys. Zeitschr. 8. pp. 674–679, Oct. 15, *errata* p. 912, 1907.)—The author finds that the alkali metals give rise to a line spectrum with powerful condenser discharges, this spectrum being quite different from the well-known series spectrum obtained with the arc. The strength of the discharge necessary to produce this second spectrum is least with Cs, and increases through Rb to Li. In the case of Na and Li the new spectrum has not been obtained free from the series lines. In the case of the halogens, evidences of spectra of the same type have also been found. E. C. C. B.

2035. *Spark Spectra at very Low Temperatures.* **M. Cantone.** (Accad. Lincei, Atti, 16. pp. 901–905, June 1, 1907.)—The vacuum tube spectra of nitrogen and oxygen were produced at the temperature of liquid air. In the case of nitrogen little effect is produced in the red, yellow, and green, but the band spectrum is replaced by a spectrum of lines, each line being slightly on the red side of the maximum of the corresponding band, but not more than 0·5 $\mu\mu$. This fact speaks against the probability of the line spectrum being due to dissociation. Koch's idea that the chief auroral line is due to nitrogen in extreme cold is not confirmed, since no nitrogen line is found at 557 $\mu\mu$ at the temperature of liquid air. As regards oxygen, its spark spectrum is reduced to four lines and three bands, the lines being at 635, 615 (strongest), 544, and 534 $\mu\mu$. Of these, the first is a new line not found at ordinary temperatures. The bands are 604 to 594, 563 to 559, and 528 to 525.

E. E. F.

2036. *Arc Spectra.* **L. Puccianti.** (N. Cimento, 14. pp. 218–224, Sept., 1907.)—A description, illustrated by photographs, of an investigation of the intensity distribution in the sodium spectrum produced by the electric arc, the usual slit being dispensed with, and a series of monochromatic images of the arc being formed in the focal plane of the eyepiece. Spectrographs were taken varying the intensity of the current, the p.d., the length of the arc, and the disposition of the carbons. The results obtained completely confirm those of Lenard [see Abstract No. 533 (1904)], and show that the degree of excitation of the arc decreases with the p.d. between the carbons, also with increase of the conductivity, and with the density of the vapour. The cause of the hollows in the images is not chemical but physical, identical results being obtained using NaCl, Na_2CO_3, or metallic sodium. W. H. SI.

2037. *Absorption and Emission Spectra of Neodymium and Erbium Compounds.* **J. A. Anderson.** (Astrophys. Journ. 26. pp. 73–94, Sept., 1907.)—The emission spectrum is that which the compound gives out under the influence of kathode streams, while the absorption spectrum was determined for the solid substance by observing the light reflected from it. Some observations were also made on the absorption by solutions. The author finds that the bright band emission spectra of the oxides correspond exactly to their absorption at the same temperature. The absorption changes with temperature, the bands widening and shifting toward the red with rise of temperature. The absorption is different for different compounds of the same element, and also is altered by the presence of water of crystallisation very much in the same way as by a rise in temperature. The author explains the results on the basis that the electron in the metallic atom is the vibrator, and that its period is modified by the presence of other atoms or molecules. E. C. C. B.

2038. *Emission Spectra of the various Regions of the Glow Discharge in Zinc and Cadmium Vapour.* **A. Pospielow.** (Deutsch. Phys. Gesell., Verh. 9. 17. pp. 333–346, Sept. 15, 1907. From the Phys. Inst. d. Univ., Erlangen.)—The author has examined the spectra of different regions of the glow discharge through Cd and Zn vapours in vacuum tubes with and without electrodes, and at various pressures. He finds distinct differences between the positive column and the negative glow, and also variations in the colour of the discharge at different pressures. Measurements are also given of the potential gradient and, finally, some observations upon the behaviour of the electrodes in alloying with the Zn and Cd. E. C. C. B.

■ **2039.** *Secondary Maxima of Grating Spectra.* **R. W. Wood.** (Phil. Mag. 14. pp. 477–482, Oct., 1907.)—Gives a simple method of obtaining by the vector polygon the secondary maxima for grating spectra. For the full details and diagrams the original paper should be consulted. The following application to a three-line grating will illustrate the principle of the method. The first-order spectrum comes in such a direction that the path-difference is λ and the corresponding phase-angle 360°. But at a position midway between this and the central image the phase-angle is 180°, thus the vector polygon for the three-line grating gives a resultant equal to the effect of one line, the effects of the other two cancelling. Hence there is a secondary maximum at this place. Gratings with 4, 5, 6, 7, 8, and 12 lines each are also treated. E. H. B.

2040. *Phenomena of the Inverse Longitudinal Zeeman-effect.* **L. Geiger.** (Ann. d. Physik, 23. 4. pp. 758–794, Aug. 22, 1907. Extract from Dissertation, Göttingen.)—The inverse Zeeman-effect, or the magnetic rotation of plane-polarised light in the neighbourhood of an absorption band, was observed in the case of the first two pairs of Na and K, and also for the Li line λ = 6708. In the case of Na, the breadth of the absorption lines and their magnetic rotation were found to be in linear relation to the density of vapour in the absorbing flame. Complete details of the apparatus and the results obtained are given in the paper. E. C. C. B.

2041. *Photographic Observation of the Doppler-effect in Canal Rays.* **J. Stark.** (Phys. Zeitschr. 8. pp. 397–402, June 15, 1907.)—In reply to some negative results obtained by Hull [Abstract No. 1005 (1907)] and Thomson [Abstract No. 1069 (1907)], the author gives details of the conditions necessary in recording the Doppler-effect in canal rays. In every case the displaced spectrum lines of the canal rays seen in the line of propagation are accompanied by the corresponding undisplaced line. These steady lines are probably due to emission by neutral molecules ionised by the canal rays as they pass them with a much higher velocity. There is not necessarily a close connection between the intensities of the steady component and the displaced components. The former may come out photographically more strongly than the latter, and thus indicate an apparent absence of the Doppler-effect. This is confirmed by the fact that at higher pressures and densities the absorption of canal rays is greater, and the steady line is the most prominent. It is essential that the canal rays should have a high speed, as that gives them a higher luminosity and a greater prominence to the displaced component. E. E. F.

2042. *Thermoluminescent Limestone* [from Visimo Utka]. **N. T. Beljaeff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. 8. pp. 1240–1243, 1906.)—When this limestone is heated it becomes luminous at 160–180°, and remains so for 0·5–1 hour, and, in some cases, longer. The maximum of light-intensity is reached at 200–220°. If the mineral is repeatedly heated the intensity of the light emitted always assumes the value corresponding with the temperature attained, provided that the critical temperature of 300°—which causes permanent destruction of the phenomenon—is not exceeded. Cooling to −160° or −180° has no influence on the capacity of the mineral to luminesce, whilst the action of radium is not able to renew this property when it has been destroyed by heating above 300°. T. H. P.

2043. *Decrease of Phosphorescence.* **A. Werner.** (Ann. d. Physik, 24. 1. pp. 164–190, Oct. 8, 1907. Extract from part of Dissertation, Kiel.)—The light of luminescent bodies consists of distinct bands which obey separate laws of decreasing luminosity. It is therefore necessary in determining these laws to single out some special band for measurement. The author accomplishes this in the case of Zn-Sr sulphide with addition of CaF_2 by using a yellow filter, which only transmits the chief band centreing about 550 $\mu\mu$. The exciting light is from a Heraeus quartz mercury lamp, filtered through "ultra-violet glass." It appears that the maximum luminosity is sometimes attained in a few seconds, and decreases on further exposure, apparently because the radiating power is increased by prolonged illumination. The dissipation of the luminosity takes place simultaneously by two processes, one a logarithmic momentary process, and another a very much slower process. The momentary process becomes more pronounced with the age of the luminous substance. The slow process is best produced by slow kathode rays. It appears that there is also some connection between the wave-length of the exciting light and the process by which the phosphorescence disappears. E. E. F.

2044. *Uranium X.* **V. F. Hess.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 109–128, Jan., 1907. From the II. Physikal. Inst. d. Univ., Wien.)—Moore and Schlundt have stated that UrX is quite insoluble in various organic liquids, and that these give a means of separating it from uranium. They also find that UrX gives α-rays as well as β-rays. To separate UrX from uranium the author finds that, of the liquids mentioned, acetone and methylacetate are most efficient, but that the separation is by no means perfect, at least when pure substances are used. On the other hand, the addition of a small amount of impurity, especially ferric hydroxide, as recommended by Schlundt and Moore, makes the separation practically perfect. Levin's method—boiling with soot or animal charcoal [Abstract No. 1884 (1907)]—does not produce complete separation. The range of the α-rays from UrX is found 1·07 cm. in air—smaller than of those from uranium—the smallest, in fact, of any known α-rays. Within the accuracy of the experiments the rate of decay of the α-radiation from UrX is the same as that of the β-ray activity. R. S. W.

2045. *A Radio-active Product of Actinium.* **S. Meyer** and **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 315–322, Feb., 1907. From the Inst. f. theoret. Physik. u. d. II. physikal. Inst. der k.k. Univ., Wien.)—It has previously been shown that if a plate be exposed for a long time to actinium emanation, after the disappearance of AcA, there is still a small remanent activity which can be detected after 50 days [Abstract No. 100 (1906)]. On account of the small amount of active matter present the investigation of this activity is difficult; nevertheless, some approximate measurements of the decay have been made. Exposure of the plates to the emanation is made for periods varying from 22 days to 202 days, and measurements are begun some hours after their removal from the gas. The tables given show that observations have been made over 80 days; a logarithmic decay is found, with half-value period of 12 days approximately. At the beginning of the observations there are indications of the presence of two substances. The radiation emitted is readily absorbed by thin aluminium sheets; heating to a bright red does not cause volatilisation. No emanation can be detected. It is concluded that the substance giving this remanent activity is a new radio-active product. R. S. W.

2046. *Ionisation Curve of Methane.* **W. H. Bragg** and **W. T. Cooke.** (Royal Society of South Australia, Transactions, Vol. 31, 1907. Phil. Mag. 14. pp. 425–427, Sept., 1907.)—Compares the stopping power of air with that of a gas containing much hydrogen, such as methane, when traversed by α-particles. The pressure and temperature of the air were adjusted so that the ranges of the α-particle from radium itself were the same in both. The more energetic particles go further in methane than in air, thus showing that the ratio of the stopping power of methane to that of air increases somewhat as the speed of the particle diminishes. This agrees with Bragg's previous conclusion. As a consequence the four steps of the ionisation curve are more clearly shown in methane than in air. The stopping power of methane, compared to air, is 0·860 for RaC and 0·880 for RaA. This seems to show that the stopping power of hydrogen is rather lower than the value previously given; but the exact determination depends on the value adopted for the carbon atom, which is at present the subject of investigation. The total ionisation in methane was found to be 1·165 times greater than in air. Initial recombination effects were small, probably less than in air; experiments on this point are not yet complete. E. E. F.

2047. *Fall of induced Radio-activity.* **E. Sarasin** and **T. Tommasina.** (Comptes Rendus, 145. pp. 420–422, Aug. 19, and pp. 482–485, Sept. 2, 1907. Archives des Sciences, 24. pp. 437–468, Nov., 1907.)—Every body "activated" with a charge has two curves of disactivation. For bare conductors the curve of positive discharge is always the highest, while for conductors covered with an insulating layer the negative discharge curve is the higher [see Abstract No. 782 (1905)]. The authors describe some new researches undertaken for the purpose of elucidating this phenomenon. They find that a body activated with negative charge gives a single discharge curve for both signs, and so does a bare conductor negatively charged and activated. A negatively charged and insulated conductor gives two discharge curves for the first half-hour or so, the positive curve (due to the emission of electrons) rising, and the negative curve falling, until both coalesce and fall together. The authors interpret this as meaning that electrons penetrate into the insulating layer and then slowly emerge from it. On interposing wire gauze in the path of the discharge the discharge curve is always doubled, the positive curve being highest in the case of a bare wire or an uncharged insulated wire, but lowest when the wire is activated and negatively charged. In the second paper the authors give a number of curves demonstrating the action of wire gauze screens with meshes ranging from 2 cm. to 0·2 mm. width, as specified in the preceding paper. E. E. F.

2048. *Demonstration of Radio-activity.* **G. A. Blanc.** (N. Cimento, 14. pp. 73–77, July–Aug., 1907.)—Experiments on radio-activity can be made with little trouble or cost by means of thorium hydrate precipitated from the solution of thorium nitrate by excess of ammonia. It is dried and powdered, and after three weeks it will have recovered sufficient radio-activity for purposes of demonstration. The author describes how with 10 gm. of thorium hydrate, costing some 3 shillings, the main phenomena of emanation, ionisation, and secondary radio-activity may be shown. E. E. F.

2049. *Radio-active Matter in the Earth and the Atmosphere.* **G. A. Blanc.** (N. Cimento, 14. pp. 199–213, Sept., 1907.)—An amplification of a previous paper [Abstract No. 838 (1907)] in which the radio-activity induced in a negatively charged wire on exposure to air is attributed to transformation products of radium and thorium. The ionisation produced in unit volume of atmospheric air may be due to (1) radio-active emanation, (2) solid transformation products, radium A and C, thorium B and C, 5–10 per cent. of the total number of ions produced in this way being due to thorium B and C, and (3) transformation products deposited on bodies which remain permanently exposed to the air, 40–75 per cent. of the activity induced by these means being of the thorium type. W. H. St.

2050. *Radio-active Matter in the Atmosphere.* **A. Gockel.** (Phys. Zeitschr. 8. pp. 701–703, Oct. 15, 1907. Paper read before the Schweiz. Naturforscherversamml., Freiburg.) — An account of observations made at Freiburg, in Switzerland, and on the Brienzer Rothorn at a height of 2,300 m. It was found that on exposing above the surface of the ground a wire charged to a potential of —2,000 volts for a period of 10 to 12 hours a considerable quantity of an active thorium deposit was collected on the wire [compare Blanc, preceding Abstract]. By means of the instruments of Elster and Geitel the activity was still easily observable 48 hours after the removal of the wire. In general, on clear days a higher value of the activity was obtained than on dull rainy days. J. J. S.

2051. *Radio-activity of Ordinary Substances.* **H. Greinacher.** (Ann. d. Physik, 24. 1. pp. 79–104, Oct. 8, 1907. Physikal. Inst. d. Univ., Zürich, July, 1907.)—The known radio-active elements are very few, and the question arises whether radio-active properties are not possessed by all kinds of matter. The case may be analogous to that of magnetism, which at first appeared to be a property of some elements of the iron group only, but afterwards was found to be common to many other bodies, though in a slighter degree. The author investigated various substances with a view to finding whether there was any indication of the radiation of particles. The method adopted was a thermal one, and tests were made to determine whether the substances examined showed any trace of being at a higher temperature than their surroundings. The materials examined were placed in Dewar vessels surrounded by ice and kept there for many hours, their temperature being measured by means of a thermoelectric arrangement. The substances investigated were $ZnSO_4$, $CdSO_4$, $MgSO_4$, Zn, Cd, $UO_2(NO_3)_2$, Hg and Bi and $Pb(NO_3)_2$, and it was found that the temperature-differences which these (with the exception of lead nitrate) showed above their surroundings amounted to at least less than 0·01°. Crystalline lead nitrate was an unexplained exception, as it showed a temperature of one or more hundredths of a degree less than that of its surroundings. It was calculated that the heat which the investigated substances could have produced by a radio-active transformation amounted at most to some millionths of that of radium, for Hg especially 1/1000000 was found as upper limit. It was thus indicated that the method of Dewar vessels permitted of an accurate determination of the heat development of radio-active substances. The temperature-fall (radial) in an endless cylinder was calculated if its surface was kept at constant temperature. The magnitude of this temperature gradient was also deduced from a more general formula obtained by the author, and the result is that the values calculated in this way are considerably smaller than those found experimentally by Thwing. J. J. S.

REFERENCES.

2052. *Rays and Wave Surfaces in Isotropic Media.* **A. Garbasso.** (Accad. Lincei, Atti, 16. pp. 518–525, Oct. 20, 1907.)—A continuation of the work dealt with in Abstract No. 1626 (1907).

2053. *Fluted Spectra and Supplementary Flutings from Parallel Gratings.* **G. Meslin.** (Journ. de Physique, 6. pp. 853–885, Nov., 1907.)—The full paper corresponding to Abstract No. 848 (1907).

2054. *Helium in Natural Gas.* **H. P. Cady** and **D. F. McFarland.** (Amer. Chem. Soc., Journ. 29. pp. 1523–1535, Nov., 1907.)—Analyses of gas and map of district. [See Abstract No. 660 (1907).]

2055. *Propagation of Light in Moving Bodies on the Principle of Relativity.* **M. Laue.** (Ann. d. Physik, 23. 5. pp. 989–990, Sept. 24, 1907.)—Shows how to obtain expressions for the speed of light in moving bodies on Einstein's electrodynamical system which is based on the principle of relativity. E. H. B.

2056. *Theory of Halos.* **J. M. Pernter.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 17–48, Jan., 1907.)—Discussion of the various theories which have been propounded to explain the conditions governing the formation of solar and lunar halos. A useful table is included, summarising authenticated observations of these phenomena from 1735 to 1906. C. P. B.

2057. *Anomalous Dispersion.* **J. Hartmann.** (Astronom. Nachr., Nos. 4197–8. p. 341, Sept. 2, 1907. Nature, 76. p. 527, Sept. 19, 1907.)—The author discusses the application of the theory of anomalous dispersion as a possible explanation of various astronomical phenomena, such as the solar chromosphere, sun-spots, prominences, faculæ and flocculi. A useful bibliography of other similar papers is appended. C. P. B.

2058. *Rotation of Plane of Polarisation by Solutions.* **J. J. Thomson.** Cambridge Phil. Soc., Proc. 14. pp. 313–317, Oct. 15, 1907.)—A highly analytical paper which discusses under what conditions a collection of atoms would possess the power of rotation if each atom consisted of a number of electrified parts rigidly connected together. E. H. B.

2059. *Magneto-optical Properties of Colloids and Heterogeneous Liquids.* **A. Cotton** and **H. Mouton.** (Annal. Chim. Phys. 11. pp. 145–208, June, and pp. 289–339, July, 1907.)—A long paper dealing principally with the magneto-optical properties of colloidal ferric hydroxide solutions. [Compare Abstracts Nos. 2046 (1905), 535 (1906), and 1503 (1907).] T. H. P.

2060. *Doppler-effect in Spectrum of Hydrogen and Mercury.* **G. F. Hull.** (Astrophys. Journ. 26. pp. 117–119, Sept., 1907.)—Reply to a former note by J. Stark, and acknowledging that Paschen's confirmation of Stark's results make it clear that under certain conditions for the mercury lines some of the luminous particles in the canal stream of that gas are in rapid motion. C. P. B.

2061. *Latent Fluorescence and Optical Sensitisation.* **J. Stark.** (Phys. Zeitschr. 8. pp. 248–250, April 15, 1907.) *Fluorescence of Benzene-derivatives.* **J. Stark** and **R. Meyer.** (Ibid. pp. 250–255.)—The leading points of these two papers have already been described [see Abstract No. 1347 (1907)]. The present communications give important additional details, including curves showing the absorption spectra of 18 benzenoid compounds. T. M. L.

HEAT.

2062. *Calorimeter for Liquids and Gases.* **C. Féry.** (Soc. Franç. Phys., Bull. 2. pp. 182–186, 1907.)—The author refers to the defects of the Berthelot and Mahler bomb types of calorimeter for quick work, and to the disadvantages attending the use of Junker's more generally used gas-calorimeter. He then describes a form of gas-calorimeter devised by himself, which is simple in construction and accurate in its results. Two straight and thin cylindrical glass tubes, of equal length and diam., are joined below by a metal tube which terminates in two metal holders, into which the glass tubes tightly fit. The tubes are closed above by perforated nickel caps, similar to those employed in the Méker boiler. A thermo-element of constantan and copper is soldered to these caps. The combustible gas or liquid is now burned in the left-hand combustion tube by aid of the usual accessory appliances, the current of air for supporting the combustion being drawn down the right-hand tube and across the supporting arm by the metal connecting tube. The products of combustion pass up the second tube and escape through the nickel cap into the atmosphere. The two nickel caps are thus maintained, the one at the temperature of the incoming air and the other at the temperature of the exit gases, and this difference in temperature is measured by the e.m.f. produced by the thermo-couple. The average difference of temperature is about 400° C.; this produces an e.m.f. of about 16 millivolts in the thermo-couple. The apparatus is standardised by means of a lamp burning amyl acetate. By the use of accessory devices for measuring and recording the volume and density of the gas, also the variations in e.m.f. of the thermo-couple, the calorimeter can be made into a recording one. The gas consumption of the apparatus is from 7 to 15 litres per hour. J. B. C. K.

2063. *Melting-points of the Iron Group Metals by a New Radiation Method.* **G. K. Burgess.** (Bureau of Standards, Bull. 3. pp. 345–355, Aug., 1907. Amer. Electrochem. Soc., Trans. 11. pp. 247–255; Discussion, pp. 255–258, 1907.)—The method used consists in heating a small quantity of the metal whose melting-point is to be observed on a platinum strip through which a current is passed. This is surrounded by a blackened brass tube with a mica window, and the sample is simultaneously watched by two observers through a microscope and an optical pyrometer. In the calibration of the optical pyrometer 1,753° was taken as the Pt melting-point. The correction for absorption and reflection by the mica is about 15°, and the correction for the selective emission of Pt for the light used—in this case red, $\lambda = 0{\cdot}66\ \mu$—is known to 10° in the range used. The mean values found are as follows:—

Metal.	Purity.	Melting-point.
Iron	99·95	1,505° C.
Chromium	98–99	1,489*
Cobalt	99·95	1,464
Nickel	99·95	1,435
Manganese	98–99	1,207

[* 1482° erroneously given in second reference.]

Of these the Co- and Ni-points appear to be correct to within 5°, while the uncertainty of the Fe-, Cr-, and Mn-points is probably less than 10°. All were observed in an atmosphere of hydrogen. On account of its being so sharply marked, and the facts that Co is less readily oxidisable than the other metals of this group, that the oxide is not very soluble in the metal, and that the ordinary impurities do not greatly reduce the melting-point, the melting-point of Co is regarded as particularly suitable for standardisation purposes, and its accurate establishment is very desirable. The method described can be used on quantities less than 0·001 mgm., and any compound which is reduced to the metal in hydrogen may be used in determining the melting-point, with the same results as if pure metal be used. Strips other than Pt may be used to support and heat the sample—*e.g.*, iridium, carbon, and, it is hoped, tungsten. F. R.

2064. *An Accurate Calorimeter.* **W. P. White.** (Phys. Rev. 25. pp. 137–138, Aug., 1907. Abstract of paper read before the Amer. Physical Soc., April 19–20, 1907.)—An arrangement is described by which everything within the calorimeter case is at one of two temperatures—that of the calorimeter water or that of the jacket water; the difference between these temperatures (20° C. usually) is measured, so that lagging temperatures of the metal parts are eliminated. Seven preliminary measurements are stated to show that the average variation is only 2 parts in 10,000. Calibrations by the electrical method are being carried out. L. H. W.

2065. *Melting-point of Pure Tungsten.* **H. v. Wartenberg.** (Ber. Deut. Chem. Gesell. 40. pp. 3287–3291, 1907.)—A form of kathode-ray vacuum furnace was employed, in which the kathode consisted of two water-cooled copper tubes joined by a Wehnelt oxykathode. As anode a glass-sheathed iron wire, provided at the top with a magnesia tube into which other similar tubes could be slid, was used. The tungsten, made by mixing pure tungsten into a paste with 10 per cent. tungstic acid, pressed into the form of a rod and reduced in hydrogen, was placed in the inner tube. The pressure in the vessel was first reduced to 0·01 mm. and the current density progressively increased. At 20 amps. the tungsten begins to sink, and with 800 watts (the surface being 70 mm.^{2}) melts to a bead. After cooling the furnace is opened, a new, shorter magnesia cylinder inserted, so that the tungsten projects, and the melting repeated three or four times. A Wanner pyrometer was used to measure the temperature, standardised by determining the melting-point of gold and making use of the Wien-Planck formula. It is concluded that the melting-point is at least 2,800° and probably not over 2,850°. The positive crater of the arc was at a temperature 3,350° as compared with Reich's value, 3,480°. The chief physical characteristics of the tungsten so obtained are the following: Structure, radio-crystalline; density, 17·6–18·3 (powdered tungsten, 19·0–19·2); colour and surface like highly polished Pt; can be indented by a knife, and is brittle. L. H. W.

2066. *Thermal Conductivity of Insulators.* **J. Koenigsberger** and **J. Disch.** (Ann. d. Physik, 23. 4. pp. 655–670, Aug. 22, 1907. Physikal. Inst., Freiburg.)—Fourier's analytical theory of heat is not a physical explanation but a mathematical scheme, in which the thermal conductivity is arbitrarily assumed to be independent of temperature and pressure. Fourier's differential equation $\partial u/\partial t = a^2 \Delta u$ is applicable to so many branches of physics because it expresses a first approximation in any physical change. But the constant a^2 is really a function of dependent variables. The conductivity depends upon the temperature, the diffusion-coefficient upon the concentration, the electrical conductivity upon the potential, the frictional coefficient upon the speed, &c. The evaluation of the temperature-coefficient of thermal conductivity is specially difficult in insulators, as evidenced by the discrepancies among different observers in the cases of sulphur and solid paraffin. Errors are chiefly due to the lack of uniformity of the specimen, and to errors in estimating the distance between known temperature points. Both these sources of error may be eliminated by reversing the direction of the heat current. The authors devise a new method accordingly, and apply it to solid paraffin and to granite. Blocks of these substances were surrounded by vertical wooden rings, and water of two different temperatures was applied at the sides. The temperature-coefficient of paraffin turned out to be —0·00756, or about half the value found by Lees. In any case it is negative, and not positive as sometimes alleged, and there is no exception to the rule that the temperature-coefficient of heat conduction in crystalline insulators is negative. The temperature-coefficient of granite is —0·00020 between 10° and 45° C. It was measured in the wet, so as to avoid errors due to fissures. The results go to prove that in these insulators the propagation of heat is not by radiation, but purely by kinetic processes. Applying the observed temperature-coefficient of granite to the theory of the temperature gradient of the earth's interior, the author shows that the provision of heat by the disintegration of radio-active bodies is probably confined to the upper strata of the earth's crust. E. E. F.

2067. *Expansibility of "Technical" Pentane at Low Temperatures.* **F. Hoffmann** and **R. Rothe.** (Zeitschr. Instrumentenk. 27. pp. 265–271, Sept., 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The former determinations [see Abstract No. 1078 (1904)] are repeated with a modified thermostat, and it is found that within the range 30° to −190° C. a quadratic formula is not sufficient to represent the expansibility, but that one of the form $v/v_0 = 1 + \alpha t + \beta t^2 + \gamma t^3 + \delta t^4$ is necessary, with the values $\alpha = 1{\cdot}50697 \times 10^{-3}$, $\beta = 3{\cdot}4535 \times 10^{-6}$, $\gamma = 9{\cdot}75 \times 10^{-9}$, $\delta = 1 \times 10^{-11}$. Pentane thermometers graduated at only the three temperatures 0°, −80°, −190° may give readings incorrect by degrees. R. E. B.

2068. *Probable Efficiency of Accidental Gas-explosions.* **A. H. Gill** and **C. R. Haynes.** (Amer. Chem. Soc., Journ. 29. pp. 1482–1488, Oct., 1907.)—A detailed account of experiments made to determine the amount of work performed in accidental gas-explosions due to leakage from gas mains and pipes. The results show that under ordinary conditions of explosion and covering, an efficiency of only one-hundredth of 1 per cent. is all that can be expected. The loss of gas by leakage is stated to be between 7 and 14 per cent. J. B. C. K.

2069. *Movement of a Body placed in the Flux of Radiant Energy.* **N. P. Myškin.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 3. Physical Part, pp. 149–184, 1906.)—The author's experiments show that the temperature-differences of the various parts of a radiometer produce repulsion between each surface element of the apparatus and the nearest parts and also the action of a couple. The sense of the latter is that of the movement of the hands of a watch for the movable radiometer system if it absorbs radiant energy, whilst for the radiating system it is opposite to this. When the temperature is constant throughout the interior of the radiometer, the movable system—a mica disc with bifilar suspension—is subjected to the action of a couple acting in a sense opposite to that of the movement of the hands of a watch. This couple exists with artificial diffused light or with daylight and under atmospheric pressure. Its intensity varies with the intensity of the diffused light, and during a period of two years gives indications of solar radiation. T. H. P.

SOUND.

2070. *Simple Method of Fixing the Octave of the Prime of a Compound Tone.* **H. Muraoka.** (Coll. Sci. and Engin., Mem. Kyōto, 1. 3. pp. 211–216, 1906–1907.)—Frequently the pitch of a note is uncertain by an octave as, *e.g.*, the difference-tones observed by Tartini and the overtones of a fork observed by Henrici, mistakes of an octave being made in each of these cases. Thus an observer may be uncertain whether a compound tone has partials represented by the upper or the lower of the following lines of numbers :—

1 2 3 4 5 6 7 8 9 . . .
2 4 6 8 . . .

The method here advocated is to seek to detect the partials 3 and 5 in the upper line. If they are present the prime tone is represented by 1, if absent by 2, *i.e.*, the octave higher. This detection or analysis may be carried out by the unaided *musical ear* or by the help of a monochord. E. H. B.

2071. *Sensitiveness to Pitch in different Regions.* **N. Stücker.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 367–387, March, 1907. From the II. physikal. Inst. d. Univ., Wien.)—By tuning-forks (with and without wax), monochord strings, and Galton whistles the sensitiveness to pitch throughout about nine octaves is investigated by fifty observers, including some of musical culture. The results are given in detail in tables and plotted graphically. The chief points may be summarised as follows: (1) Neither the absolute nor the relative sensitiveness is constant through different parts of the compass. (2) The relative sensitiveness is for many observers a maximum in the once- and twice-accented octaves, but in some cases the maximum lies in the three- and four-accented octaves. (3) In the case of about one-third of the observers the relative sensitiveness in the second half of the once-accented octave has about the same value, namely, 0·2 to 0·3 per cent. The maximum sensitiveness lay above this region for the musically cultured and below it for the unmusical observers. (4) An extreme sensitiveness in the higher regions of the compass is characteristic of the musically cultivated observers. E. H. B.

2072. *Quality of some Orchestral Instruments.* **E. Herrmann-Goldap.** (Ann. d. Physik, 23. 5. pp. 979–985, Sept. 24, 1907. Physiolog. Inst., Königsberg, July 25, 1907.)—By means of an Edison phonograph the tone-quality was investigated for the oboe, trumpet (in B♭), tenor trombone, French horn (in F), flute, and clarinet (in B♭). The notes of each instrument were examined through the range of about an octave, the vibration-curves being traced for each case. Contrary to the usual view, due to Helmholtz, the author concludes that the tone-quality of each instrument is characterised by a special prominence of those partial tones at or near a pitch fixed independently of that of the note sounded. Hence on this view the distinction of quality among the tones in question is like that between the different vowels.

E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2073. *Ohm's Law and Electron Theory.* **E. Lecher.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 49–60, Jan., 1907. From the Physikal. Inst. d. k.k. Deutschen Univ., Prag.)—Various theories have been propounded at different times ; according to some the resistance of a conductor should increase with the current, while exactly the converse should occur according to others. From the electron theory, if there is anything of the nature of a saturation current, then for large currents the resistance would be increased. About 1 m. of wire forms part of a Kelvin bridge ; its resistance is measured while ½ amp. is passing. At the same time it is heated by a row of gas burners, its length while hot being carefully noted. It is next heated by a current of 80 amps. approximately, so that its length is the same as in the first case—and therefore presumably the temperature also—and its resistance again measured. No difference is found. If the electrons be looked upon as moving with a common velocity v, if their number per c.cm. be N, and the electrostatic charge of each e, then the current i in electrostatic units is $i = Nev$. Putting $e = 10^{-10}$ and $N = 10^{20}$, v in the experiments would be of the order 200—70,000 cm./sec. Evidently the electrons are so numerous that nothing like a saturation current is attained. R. S. W.

2074. *Motion of Ether due to Atomic Collisions.* **Kelvin.** (Electrician, 59. pp. 714–716, Aug. 16, 1907. Phil. Mag. 14. pp. 317–324, Sept., 1907. Engineering, 84. pp. 286–287 ; Discussion, p. 262, Aug. 23, 1907. Elect. Rev., N.Y. 51. pp. 363–365, Sept. 7, 1907. Écl. Électr. 52. pp. 415–417, Sept. 21, and 53. pp. 14–16, Oct. 5, 1907. Paper read before the British Assoc. at Leicester.)—In order that atoms (or electrons) may take energy from motions of ether, and that ether may take energy from motions of matter, we must suppose ether to be compressible and dilatable by the forces exerted upon it by atoms. But its resistance to compression is so very great that the velocity of condensational-refractional waves in pure ether is practically infinite, and their energy nil in comparison with light-waves of equal volume. The ether is a continuum and occupies all space jointly with atoms wherever they exist. By purely dynamical reasoning from such premises it may be proved to follow that an infinitely small atom kept moving through ether at any velocity q greater than v, the velocity of light, produces no disturbance in the ether in front of a cone having its vertex at the atom and semi-vertical angle equal to $\sin^{-1}(v/q)$, but that the moving atom produces in its rear wholly within the cone an ever-growing disturbance of ether, and therefore requires the application of a continual pull forward to keep it moving uniformly at any constant velocity exceeding the velocity of light. The author also deduces the following further conclusions by dynamical reasoning : (*a*) No force is required to keep an atom moving uniformly through ether at any velocity less than the velocity of light. (*b*) To start an atom suddenly into motion from rest causes a spherical pulse to travel outwards with the velocity of light, from the place in which the atom was when it was receiving the supposed velocity. (*c*) The magnitude of this spherical pulse is a maximum in the plane through the centre perpendicular to the line of motion, and is zero at the two points in which the spherical surface is cut by that line. (*d*) This spherical pulse carries outwards through infinite space a finite quantity of energy, *l*, due to a part of the work, *w*, done by the force which was applied to the atom to start it in motion. The sharper the suddenness the greater is *l*. (*e*) If at any time a resisting force suddenly stops the atom, work is done on the ether, in virtue of which another pulse carries away an amount of energy *l′*; and work is done on the stopping agent amounting to $w - l - l'$. (*f*) If the suddenness of the stopping is equal and similar to the suddenness of the starting, the second pulse is equal and similar to the first, and *l′* is equal to *l*. The author considers it exceedingly probable that the persistence of the two-atom molecule in the common diatomic gases is due to the impossibility of electrically neutralising the ponderable atom by any integral number of electrons ("electrions"). He regards the multiplicity of spectrum lines as due to the presence of many electrons in the atom, each with many positions of equilibrium within it. E. E. F.

2075. *Electromagnetic Mass of a Moving Electron.* **E. Cunningham.** (Phil. Mag. 14. pp. 538–547, Oct., 1907.)—Deals with Abraham's objection to the Lorentz conception of an electron as having, at rest, a spherical shape, but in motion the shape of an oblate spheroid with axes depending upon the velocity relative to the ether. The author shows that Abraham's objection is not valid, utilising the fact that Maxwell's equations represent equally well the sequence of electromagnetic phenomena relative to a set of axes moving with respect to the ether, as relative to a set of axes fixed in the ether.

E. E. F.

2076. *Variation of Mass of Electrons.* **H. Pellat.** (Comptes Rendus, 145. pp. 673–676, Oct. 21, 1907.)—An attempt to solve the difficulties attending the hypothesis of the emission of spectrum lines by revolving electrons. The majority of spectrum lines are not simple, but attended by satellites, bands or flutings. The author regards these perturbations as due to a variation of the electromagnetic mass of an electron owing to the overlapping of its magnetic field with the magnetic field of an electron moving in a neighbouring orbit. The mass of an electron equals twice the ratio of its magnetic field to the square of its velocity. If two neighbouring electrons have the same velocity, their combined field energies may be either more or less than the sum of their separate field energies, and the same may then be said of their electromagnetic masses. As the electrons approach to within their respective spheres of influence—*i.e.*, the spheres outside which their field energy is negligible—their combined mass decreases. On very close approach it increases again, and may become larger than the sum of their separate masses. Two electrons revolving in neighbouring orbits may approach each other closely at one revolution, but be free during the majority of revolutions. This would explain the maximum luminosity of a band or fluting. E. E. F.

2077. *Number of Electrons in an Atom.* **N. Campbell.** (Cambridge Phil. Soc., Proc. 14. pp. 287–291, Oct. 15, 1907.)—The atom is supposed to consist of electrons moving in a sphere of positive electricity, and the number of electrons is calculated from the hypothesis that in the case of radio-active substances the energy of explosion is derived from the fall, towards the centre of the atom, of electrons previously rotating. The number of electrons in the atom of radium is thus calculated to be greater than 1,200. E. H. B.

2078. *Free Displacement of Electricity.* **T. Levi-Civita.** (Comptes Rendus, 145. pp. 417–420, Aug. 19, 1907.)—Presents the undulatory theory as a special case or limiting case of the emission theory. Suppose there is a pure electromagnetic field, *i.e.*, produced entirely by the motion of electricity, without the intervention of ponderable matter or of linkages between electric charges or any external action. It can then be proved that in such a pure electromagnetic field no electric charge can exist in the state of rest. But it does not follow that a true transportation of electricity without linkage or external force is impossible. The author gives one particular solution of the Hertzian equations by which it becomes possible. There may be others corresponding to the motion of an isolated electron, and this holds out a prospect of dispensing with kinematical linkages such as figure at present in all mechanics of electrons. In the author's solution the electricity moves with the velocity of light, so that if it is corpuscular the motion of light becomes corpuscular also. E. E. F.

2079. *Electrical Action of the Sun and Moon.* **A. Nodon.** (Comptes Rendus, 145. pp. 521–523, Sept. 16, 1907.)—Observations made at the Astrophysical Observatory on the Pic du Midi, at an altitude of 2,877 m. during the days of Aug. 20 and 21, 1907, to measure the electrical charges induced by the sun and moon, and the variations between the variations of the solar potential and that of the ground. It was found that the sun induced a positive electric charge, which is greater when the air traversed by the solar radiation is dry, and which is entirely absorbed by any cloud which may pass in front of the solar disc, or by layers of humid air. The solar charge varied from 1 to 6 volts per min. The moon produced a similar positive electrification. Variations of the ground potential are much more intense at high altitudes than at the earth's mean surface-level, approaching in some cases to 400 volts per min. C. P. B.

DISCHARGE AND OSCILLATIONS.

2080. *Ionisation by Spraying.* **A. S. Eve.** (Phil. Mag. 14. pp. 382–395, Sept., 1907.)—The sprayer used was one of Becker's, in which a steady current of air, filtered through cotton-wool, enters a horizontal conical entrance into a glass containing a layer of liquid, and draws the liquid up through a vertical cone having a small hole near its base. The spray and air together pass through about 50 cm. of tubing into the testing vessel, a cylindrical condenser and electroscope. The ions could be entirely removed by a plug of cotton-wool introduced between the sprayer and the electroscope. In the case of spray from substances such as chloroform, amyl, ethyl, benzyl or methyl alcohols, methyl iodide, acetic acid, acetone, aldehyde, and amyl acetate, the numbers of positive and negative ions were equal for each substance. Liquids such as benzene, rhigoline, phenetol, cineol, toluene, turpentine, even the most volatile, gave but few ions compared with water, and mercury gave none. Some of the ions of ether or benzyl alcohol are extremely inert, the electroscope showing leakage for 10 min. after introduction. The slowest ions of benzyl alcohol have a velocity of about 10^{-4} cm./sec. in a field of 1 volt/cm. Some ionisation is traceable even 2 hours afterwards. E. E. F.

2081. *Electric Dispersion by Heated Metals.* **A. Occhialini.** (Accad. Lincei, Atti, 16. pp. 119–126, July 21, 1907.)—In the neighbourhood of an incandescent body the surrounding gas is ionised, as if by Röntgen rays, to an extent which depends on the nature of the body and of the gas and on the pressure of the latter, and on any chemical action there may be between the incandescent body and the surrounding gas; and incandescent metals, at atmospheric pressures, cause the dispersion of positive more readily than of negative charges. Incandescent platinum in air undergoes no chemical change, and below certain temperatures its dispersing effect is due (McClelland) to positive ions alone, above these temperatures to both positive and negative ions. The author rejects McClelland's explanation [Abstract No. 1090 (1902)], and attributes the dispersion not to ions produced by ionisation of the surrounding gas, but to a break-off from the metal. This is manifest even at ordinary temperatures, the emission of negative ions being abundant, at 9,000 volts/cm. between the charged body and the metal, and in weaker fields it becomes manifest at higher temperatures. According to modern views negative ions move freely in metals in a network made up of positive ions, and the energy of their movement represents the absolute temperature of the metal; and some of these may be projected from the surface or withdrawn by the action of an electrostatic field. The emission of positive ions is always subordinate to the presence of a surrounding gas, but they may come from within the metal, from the dissociation, by heat, of gases occluded within the metal. A large range of theoretical deductions from this hypothesis is confirmed by experiment: when the metal is kept positively charged, heating the metal impedes the positive effluvium across an electrostatic field. In a subsequent note (ibid. pp. 191–195, Aug. 4), it is shown that the effect attributed to the dissociation of molecules of gas occluded within the metal wears out, or is brought to an end when the metal, by repeated heating or heating to a high temperature, has had its occluded gases removed or greatly reduced in quantity. A. D.

2082. *Some Actions of Ultra-violet Light.* **J. G. Davidson.** (Phys. Zeitschr. 8. pp. 658–659, Oct. 1, 1907. From the English.)—When metal wires have been kept in a region where ionisation existed they are accustomed under the action of ultra-violet light to lose a negative charge much more quickly than before. This result is sometimes obscured by changes in the metal itself—as, for example, by oxidation. It is best observed in the case of Pt or Pd, which possess a great power of absorption and are free from corrosion. A piece of Pt held in an ordinary gas flame is very active, and the same result is obtained, though in a less degree, if it is held over the flame when the gases are cold. This activity remains practically constant, whilst the wire for 2 to 8 hours gives off negative electricity under the action of the light, if it has been thoroughly heated in the flame. When the activity finally begins to slacken it falls away practically to nothing in a few minutes. If a wire which has been made active by a flame is kept for a week in dust-free air, its activity does not fall off in intensity, but it can be dispelled if the wire is heated by an electric current in air to a temperature not far above 800°. A wire becomes active if it is made to serve as electrode in an electrolytic cell, care being taken to avoid the presence of hydroxide. No activity will exist if oxygen is admitted to the wire, and such activity as the wire formerly possessed will thereby be dissipated. An inactive wire will be made active by heating in air to redness by an electric current. With platinum this activity is permanent, but, on the contrary, metals which oxidise at the temperature employed will be inactive in a few seconds at room temperature. A charged wire attains activity in flame gases no more quickly than an uncharged one. A charged or neutral wire in air which is strongly ionised by Röntgen rays or by radio-tellurium is inactive. The author has made a series of observations on the activity of wires which have been treated in various ways with rising and falling temperature in air at atmospheric pressure. In general it has appeared that those wires whose activity is to be ascribed to an alkali metal or an occluded gas exhibit a more or less distinct minimum at a temperature between 100° and 200°. The activity of the less easily oxidised metals does not exhibit this minimum. In all cases the curve rises very quickly when the wire approaches redness. J. J. S.

2083. *Photo-electric Effect.* **A. Pochettino.** (Accad. Lincei, Atti, 16. pp. 58–66, July 7, 1907.)—The emission, under the impact of ultra-violet rays, of negative electrodes which ionise the surrounding air is such [Abstract No. 1883 (1902)] that the number of these electrons is proportional to, but their velocity is unaffected by, the intensity of the impinging rays. If conductivity of metals be due to free electrons, metals impinged upon by ultra-violet rays ought to lose in conductivity; but in metals the number of these free electrons is so considerable that such impact produces no appreciable effect; and it becomes desirable to investigate the corresponding effect, if any, on the conductivity of poorer conductors than metals. Becquerel's observation of a change in the e.m.f. of a cell when one of its plates is impinged upon by light would seem to be connected with the former effect. It is, however, found that the following is the order of sensibility to the former effect: copper iodised, bromised, chlorised, oxidised, fluorised; while the following is the order of sensibility to the Becquerel-effect: copper bromised, iodised, oxidised, chlorised, fluorised. Besides, in whatever way the copper may have been superficially bromised it acts similarly as regards the former (Hertz's) effect, while with Becquerel's a strip of copper bromised by electrolysis becomes positive, while a strip of copper bromised by a brief immersion in bromine solution becomes negative upon being illuminated. The Hertz-effect is greater under rays of greater, the Becquerel-effect under rays of less, refrangibility. A. D.

2084. *Ballistic Theory of Disruptive Discharge.* **T. N. Švedov [Schwedoff].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 6. Physical Part, pp. 365–394, 1906.)—The first part of this paper, dealing with the ballistic theory of disruptive discharge applied to the case of air at ordinary pressure, has already appeared [Abstract No. 1106 (1906)]. In the second part the results are generalised for the case of variable pressures. From the author's ballistic theory can be deduced Paschen's law on the relation between the density of a gas and the explosive pressure, as well as the limits of this law and the existence of a minimal disruptive potential. The theory also leads to those quantitative properties which have been found by other authors to be characteristic for the "world of electrons." The experimental results of various authors are compared with those calculated from Švedov's formula. T. H. P.

2085. *Brush Discharge in Helium, Argon, and other Gases.* **K. Przibram.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 557–570, March, 1907. From the Inst. f. theoret. Physik. an der k.k. Univ., Wien.)—The author has already shown that the ratio of the length of the positive to the negative brush is increased when the ratio of the velocity of the negative to the positive ion is increased. [Abstract No. 1295 (1905).] Edmunds has found the velocities of the ions in helium, and their ratio is greater than in air. It follows that the positive brush should be longer; this is found to be the case. The apparatus is a modified form of the earlier one; several other gases are experimented upon. R. S. W.

2086. *Increased Sparking Distances.* **K. v. Wesendonk.** (Phys. Zeitschr. 8. pp. 395–397, June 15, 1907.)—Criticises Palmer's supposition that an electric wave is the agent which reduces the spark-potential on drawing a spark from one electrode of a Wimshurst circuit of high capacity. The effect is always accompanied by a preparatory brush discharge, unless the terminals are provided with balls of large radius. In applying this method to the positive pole, it is found that a glow discharge may often be given something of a disruptive character by drawing a spark out of the positive terminal. E. E. F.

2087. *Quantity in Induction Sparks at Low Pressures.* **S. Maresca.** (Accad. Lincei, Atti, 16. pp. 118–119, July 21, 1907.)—As the pressure diminishes with a given sparking distance the maximum secondary current steadily increases and from that maximum the secondary current falls off more slowly, the Braun tube being progressively more luminous during the latter stage; then the fall off becomes slower and the luminosity less, while the maximum secondary current falls off; and at very low pressures the secondary current falls off to a strength at which it ceases to increase with the primary current. The quantity of electricity passed in the induction spark at first increases and then falls off as the pressure is reduced. As the secondary current rises the positive column shortens, and when the maximum secondary current has been reached the positive column has disappeared and the discharge occupies the whole of the kathode. It is as if the fall of potential in the positive region went on diminishing as the pressure was reduced, the fall at the kathode remaining unchanged; but as if beyond the degree of reduction of pressure corresponding to maximum secondary currents, the fall of potential at the kathode became greater. The sparking distance and the pressure at which the maximum secondary current can be obtained are approximately inversely proportional to one another: this is analogous to Paschen's law as to explosive potentials, but the quantities of electricity passed in maximum secondary currents are less the greater the sparking distances. The amount of secondary current passing depends upon the amount of gas-pressure and very little upon the distance between the electrodes. A. D.

2088. *Effect of Diaphragms upon Spark Potential.* **L. Amaduzzi.** (Accad. Lincei, Atti, 16. pp. 398–400, Sept. 15, 1907.)—On placing a mica diaphragm with a small hole in the centre between spherical sparking knobs, the spark potential is increased when the diaphragm is midway between the knobs but is diminished when the diaphragm is close to one of the knobs. The author considers that the former effect is due to the fact that the diaphragm acts as an obstacle to the travel of the ions in the field, and therefore hinders the formation of the disruptive discharge, and that the latter is due to the distortion of the electrostatic field produced by the mica. This latter is much greater in the case of thick diaphragms and canals than in the case of thin diaphragms. The effects in the case of a point and plane in place of spherical knobs, and also when canals instead of perforated diaphragms are employed are also described, and are consistent with the author's hypotheses. S. G. S.

2089. *Vacuum Tubes.* **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 9. 14. pp. 306–314, July 30, 1907. Physikal. Inst. d. Univ., Berlin, June, 1907.)—Bubbles in the glass of old vacuum tubes, observed by Campbell Swinton on heating the glass in the blowpipe flame, and attributed by him to particles of residual gas being shot into the glass [Abstract No. 1887 (1907)], are attributed by the author to traces of aluminium deposited on the glass. On the glass being thoroughly cleaned by *aqua regia* (nitric acid not being sufficient) no such bubbles are formed on heating the glass. The phenomenon is familiar to glass-blowers who repair Röntgen tubes, &c., and it can be reproduced with an artificial coating of aluminium. Every kind of glass gives off hydrogen upon being powdered; and the glass of a helium tube gives no helium on being powdered unless it carry a surface film of aluminium. A. D.

2090. *Sliding Sparks on very Thin Plates.* **M. Toepler.** (Ann. d. Physik, 23. 5. pp. 867–874, Sept. 24, 1907. Physikal. Inst. d. techn. Hochschule, Dresden, June 21, 1907.)—A continuation of earlier researches on sliding sparks on the surface of thicker plates of glass [see Abstract No. 296 (1907)]. The observations described in the present paper were made with thin plates of mica. For all mica plates down to the thinnest (1/140 mm.) the relation $af = P^4$ holds good, where a is an individual constant of each plate, f the spark length in cm., and P the p.d. in kilovolts. The lower limit of the sliding spark length, beyond which the spark is no longer sliding but takes place through air, is approximately given by the formula $f_{\text{min.}} = 0{\cdot}1P$. The relation $P_{\text{max.}} = 500d$ was also found to hold, where $P_{\text{max.}}$ is the tension at which piercing occurs expressed in kilovolts, and d the thickness of the plate in mm. The smallest thickness of plate, such that a thinner one would be pierced, was found to be 0·005 mm.; the smallest sliding spark length 0·2 cm., and the smallest p.d. 2·5 kilovolts. J. J. S.

2091. *Minimum Discharge Potential.* **P. Pringsheim.** (Ann. d. Physik, 24. 1. pp. 145–168, Oct. 8, 1907. Extract from Dissertation, München.)—Spark potentials between a Pt point and a gold cylinder were studied within a space heated to temperatures as high as red heat by means of an electric current. The minimum potential of the negative current from the point is not constant when the point is new. But after some discharges, especially at pressures below 500 mm., it assumes a very constant value to which it always returns after heating or other disturbance. Heating above red heat at constant density reduces the negative minimum potential to a value which is not affected by further heating. As the potential is lowered, the discharge may either stop abruptly or gradually. In the former case the minimum potential is smaller than the initial potential, in the latter the potentials are equal. At pressures above 600 mm. there are often further discharge pulses after the steady discharge has ceased to flow. The positive point-discharge is affected in the same way on heating, but to a very much smaller extent. The current density increases with the temperature, a very rapid increase taking place in the negative point-discharge above 500° C. E. E. F.

2092. *Effect of Radiations on the Sparking Potential.* **J. Herweg.** (Ann. d. Physik, 24. 2. pp. 326–350, Nov. 12, 1907. Habilitationsschrift, Greifswald.—The full paper corresponding to Abstract No. 294 (1907). In addition to the results already given, the effect of the electrode material and of the nature of the gas through which the discharge passes is investigated. The limiting value of the reduction in sparking potential is different for different gases: between plates in CO_2 the reduction is up to 1/2, in air up to 1/2·8, and in hydrogen up to 1·3. For short sparks the reduction is independent of the length and of the electrode material. L. H. W.

2093. *Theory of the Singing Arc.* **D. A. Rožanskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 8. Physical Part, pp. 455–462, 1906.)—From theoretical considerations the author deduces that the conditions of stability of the singing arc are determined by the form of the characteristic curve of the arc. It is shown that the period of the arc should be greater than that of the oscillator circuit, and that it is possible to calculate the difference between them and also the amplitude of the stationary oscillations of the arc. T. H. P.

2094. *Electric Oscillations in the Circuits of the Induction Coil.* **A. A. Petrovskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 8. Physical Part, pp. 468–478, 1906.)—The author shows that it is not possible to realise the resonance between the periods of the free oscillations of the two circuits of the induction coil. It is, however, possible to bring about resonance between the secondary circuit of the coil, furnished with a condenser having a capacity of 0·003–0·03 mfd., and the period of the interruptions of the primary circuit by varying the two quantities. The maximum effect attained in the induced circuit by a definite number of interruptions per sec. was shown by the maximum disruptive voltage and by an ammeter interposed in the circuit. Variation of the capacity, C, of the secondary condenser produces a variation in the number of interruptions inversely proportional to $\sqrt{C}$. The same resonance effect can be observed when the periods of the interruptions are two or three times as great as the period of the oscillations of the induced circuit. T. H. P.

2095. *Propagation of Plane Electromagnetic Waves along a Plane Conducting Surface and its Bearing on the Theory of Transmission in Wireless Telegraphy.* **J. Zenneck.** (Ann. d. Physik, 23. 5. pp. 846–866, Sept. 24, 1907. Physikal. Inst. d. techn. Hochschule, Braunschweig. Écl. Électr. 53. pp. 337–340, Dec. 7, and pp. 414–417, Dec. 21, 1907.)—The author attacks the subject from the point of view of the theory of transmission in wireless telegraphy. After obtaining the Maxwellian equations in a suitable form he proceeds to assign values to the constants such as are usual in wireless telegraphy, and then calculates out a series of numerical results. The frequency assumed is 10^6 per sec., which corresponds to a wave-length of about 600 m. The conductivity of the plane surface is given values from 10^{-9} to 10^{-17} c.g.s. (The conductivity of a watery 5 per cent. solution of NaCl is about $0·6 \times 10^{-10}$, and that of dry sand is 10^{-17}.) The conductivity of the air is taken into consideration though it is found to be negligible as a rule. Dielectric constants from that of water (80) to that of air (1) are considered. The relation between the intensity of the components of the electric field in air, E_{0x}, and E_{0y}, which are respectively in the direction of motion of the waves and vertically downwards at the earth's surface, is—

$$E_{0x}/E_{0y} = -\sqrt{q_0/(1+q^2)}\,.\,e^{i\phi_0},$$

and $\tan 2\phi_0 = 1/q$, where $q_0 = \pi n \epsilon_0/\sigma$ and ϕ_0 is the phase angle, the other quantities being n = frequency, ϵ_0 = the dielectric constant of air, and σ = the conductivity of the ground or sea, and also $q=\pi n\epsilon/\sigma$, ϵ being the dielectric constant of the ground. For the conductor the equations are—

$$E_x/E_z=-\sqrt{\sqrt{1+q^2}/q_0\cdot e^{i\phi}}$$

and $\tan 2\phi=-1/q$ (2ϕ in the second quadrant), *i.e.*, $\phi=90^\circ-\phi_0$,

$$E_x/E_z=1\Big/\left|\frac{E_{0z}}{E_{0x}}\right|.$$

The conditions in the conductor may be obtained from the curves in Fig. 1. Representing the resultant field intensity as a vector and tracing the curves described by the end of this vector during a period of the oscillation,

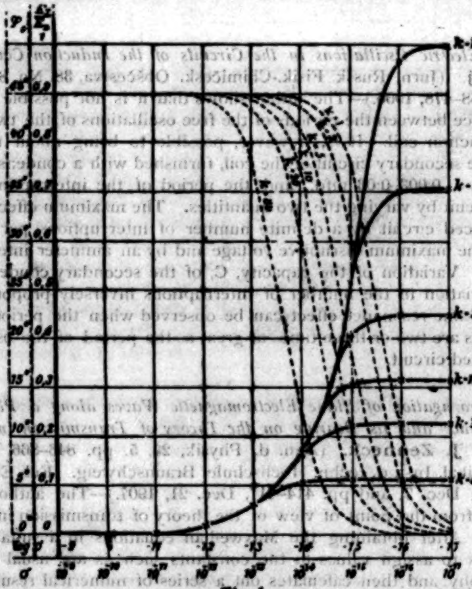


Fig. 1

diagrams are obtained which show graphically the varying direction and magnitude of the electric force during one period in air and conductor. If the conductor possesses a conductivity not much below 10^{-13} or 10^{-13} the hodograph consists in air of half of a very narrow almost vertical ellipse, and in the conductor of a short line practically parallel to the surface. The value of the dielectric constant is of no consequence in this case. With a small dielectric constant and lower conductivity there is in the air a nearly pure alternating field, which is the more inclined to the vertical the less the conductivity of the ground. In the conductor there is also a considerable rotating field component. The phase angle is in this case small. The case in which neither the phase angle nor the ratio of the X and Z components of the force are small occurs with a somewhat small dielectric constant and a conductivity—for the given frequency—of not far from 10^{-15} c.g.s. The absorption of the waves along their direction of motion is shown in Fig. 2, where 1/B is the distance, in km., at which the amplitude is reduced to 1/*e*. The ordinates of the curve are proportional to the common logarithms of 1/B.

The curves show that for a given dielectric constant the distance 1/B has a minimum, *i.e.*, the absorption is a maximum for a perfectly definite value of the conductivity. It is obvious *a priori* that this should be so since both for zero and infinite conductivity there is no absorption. The curves also show that the dielectric constant has at least as great an influence on the value of the absorption as the conductivity. A curve for absorption by penetration of the waves into the conductor is given, from which the chief conclusions are (1) that for conductivities above 10^{-13} the dielectric constant is without influence, and (2) that the absorption in 1 cm. into the conductor is equivalent to that in 1 km. along the surface. It is not quite clear that the results obtained are entirely applicable to wireless telegraphy. To begin with, it is hardly true that the waves in the latter can be considered as plane, except at great distances from their source. Secondly, it is quite possible that the waves may not be of the type represented by the equations considered. They, however, would certainly apply to waves along wires, and it appears probable that those of wireless telegraphy are not greatly different. It must also be noticed that the earth is not truly plane. The following values may be accepted for the conductivities and dielectric constants of water and land—

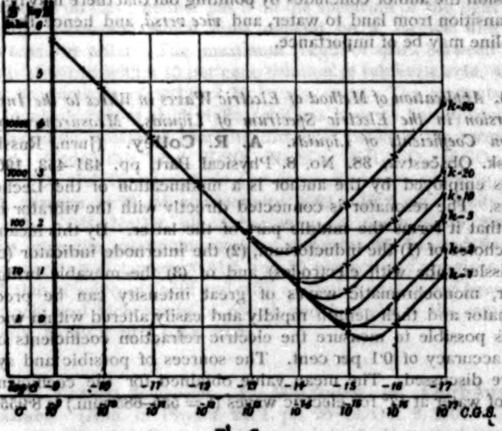


Fig. 2

Material.	Conductivity.		Sp. Ind. Cap.
Sea water	10^{-11}	c.g.s.	80
Fresh water	10^{-14}	„	80
Wet ground	10^{-13} to 10^{-14}	„	5 to 15
Dry land..	$< 10^{-15}$	„	2 to 6

The correct slope for the antenna is discussed in the light of the equations; it coincides with that found in practice. It is shown that the absorption due to sea water is practically negligible and that the maximum absorption is for conductivities between 10^{-13} and 10^{-16}. For dry land the absorption may be very great on account of the low conductivity and low dielectric constant. The conductivity of the air below 6,000 m. is shown to have very little influence on the absorption, on the assumption that it is nowhere more than 100 times the average value at the earth's surface, which is in accordance with observations. Thus, unless the upper layers of the atmosphere have a conductivity of quite a different order of magnitude, we are driven to accept Marconi's second suggestion, that the difference between transmission by day and by night is due to daylight discharging the antenna, and not to ionisation of the atmosphere. After some remarks on the advantageous influence of fog on transmission the author concludes by pointing out that there may be reflection in the transition from land to water, and *vice versâ*, and hence that the form of coast-line may be of importance. J. E.-M.

2096. *Application of Method of Electric Waves in Wires to the Investigation of Dispersion in the Electric Spectrum of Liquids. Measurement of Electric Refraction Coefficients of Liquids.* **A. R. Colley.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 8. Physical Part, pp. 431–458, 1906.)—The apparatus employed by the author is a modification of the Lecher-Drude apparatus. The resonator is connected directly with the vibrator in such a manner that it forms the middle part of the latter. By this means and by suitable choice of (1) the inductorium, (2) the internode indicator (consisting of a Geissler tube with electrodes), and of (3) the movable bridge of the resonator, monochromatic waves of great intensity can be produced in the resonator and their length rapidly and easily altered within wide limits. It is thus possible to measure the electric refraction coefficients of liquids with an accuracy of 0·1 per cent. The sources of possible and systematic errors are discussed. The mean value obtained for the coefficient of refraction of water at 17° for electric waves ($\lambda = 555$–685 mm.) is 8·955.

T. H. P.

2097. *Distribution of Energy from a Righi Vibrator.* **C. R. Fountain** and **F. C. Blake.** (Phys. Rev. 25. pp. 255–278, Oct., 1907.)—Hertz's classical diagrams showing the field round an oscillator neglected the damping, which omission was supplied by K. Pearson and A. Lee. But they neglected the fact that there is an electrostatic field about the oscillator before the oscillations begin. All these factors have been theoretically considered by A. E. H. Love, who has shown how the electric and magnetic forces may be computed for any point in the field. The present paper deals experimentally with the relative energies radiated in various directions about a Righi vibrator, and the chief results may be stated thus: (1) In computing the total energy in the field it is necessary to consider the radial electric force as well as the transverse electric and magnetic forces. (2) The electromagnetic waves spread from the spark-gap in such a manner that the energy at any point is approximately proportional to $\cos^2\theta$ (where θ is the angle between the radius vector and the equatorial plane) and inversely proportional to r^2 (where r is the distance from the spark-gap). (3) The energy due to the radial electric force varies nearly as $\sin^2\theta$ and inversely as r^4. (4) A theory which assimilates a Righi vibrator to an "electric doublet" and a Klemenčič element to a "point receiver" holds fairly well up to $3\lambda/4$ from the vibrator. E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2098. *Wehnelt Interrupter.* **G. Carro-Cao.** (Elettricista, Rome, 6. pp. 254–257, Sept. 15, 1907.)—Solutions of different substances, adjusted to equal conductivities, were used in a Wehnelt interrupter, and the strength of primary current, the p.d. at Wehnelt terminals, the frequency of interruptions, and the duration of each passage and interruption of secondary current recorded; tables are given. The duration of the dead intervals (about 0·0003 sec.) between the successive passages of secondary current was the only datum which presented uniformity; the nature of the electrolyte has no influence on this; neither has it on the spectrum of the light emitted by the active electrode, which must depend on a surface film of gas, hydrogen from the water. The maximum length of spark between Wehnelt terminals is obtained with a 10 per cent. solution of sulphuric acid, which has a specific conductivity of 33720 × 10^{-9} c.g.s. units. The amounts of conductivity to which various electrolytic solutions have to be adjusted to give the corresponding maximum sparking distances between the terminals was ascertained. Under this head, K_2SO_4, Na_2SO_4, $(NH_4)_2SO_4$, K_2CO_3, Na_2CO_3, NH_4NO_3, KNO_3, $NaNO_3$ give about the same maximum sparking distances (23 to 25, average 24·29) at conductivity 3682 × 10^{-9} c.g.s. units in every case; HNO_3, KOH, NaOH, all at the same sp. conductivity, 3234 × 10^{-9} c.g.s. units, give the maximum sparking distances 25, 24, and 24·5; while maximum sparking distances of 31·5 and 30 respectively are given with the above solution of sulphuric acid and with a solution containing equal parts of sulphuric acid and bichromate of potash and brought to the same specific conductivity, 33720 × 10^{-9} c.g.s. units. A. D.

2099. *The Vacuum Bolometer.* **E. Warburg, G. Leithäuser, and E. Johansen.** (Ann. d. Physik, 24. 1. pp. 25–42, Oct. 8, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—A theoretical investigation of the vacuum bolometer as regards loss of heat by conduction and radiation. In a particular case, the maximum of sensitiveness to radiation is proportional to the square root of the breadth of the strip; in the air bolometer it is nearly proportional to the breadth. Experiments are made with bolometers constructed according to Lummer and Kurlbaum's method, and the constants of the instruments, calculated by means of formulæ obtained in the first part of the paper, are tested experimentally. G. E. A.

2100. *Change of Resistance of Metal Wires due to Occlusion of Oxygen.* **G. Szivessy.** (Ann. d. Physik, 23. 5. pp. 963–974, Sept. 24, 1907. Physikal. Inst. d. techn. Hochschule, Stuttgart, July, 1907.)—The wires (0·1 mm. in diam.) were first annealed by passing a current through them until no further change of resistance occurred, and then oxygen was led over the red-hot wires until these became cold. The following percentage increases of resistance, due to occlusion of oxygen, were observed: Ag (commercial), 0·50, 0·33; Ag (pure), 0·57; Au (pure), no measurable change; Pt (ordinary), 0·39 after 4 hours', 2·30 after 9 hours' heating; another wire 3·33 after 5 hours' heating; Pt (pure), 2·19; Pd, no further change was observed after the first annealing, and it is hence uncertain if any change is produced by occlusion, since the alteration in resistance by annealing (from 6·4910 ohms to 6·4898 ohms may be greater than that due to occlusion of oxygen. L. H. W.

2101. *Thermodynamics of the Standard Cell.* **E. Cohen, F. D. Chattaway, and W. Tombrock.** (Zeitschr. Phys. Chem. 60. pp. 706–727, Oct. 28, 1907. Van't Hoff Laborat., Utrecht, June, 1907.)—The Daniell cell in the form hitherto used is not suited for accurate measurements, but it is possible to construct other forms to supply the thermodynamic data which have hitherto been lacking. The electromotive behaviour of copper amalgams varying in composition from 1 to 16 per cent. was studied in cells of the type :—

copper amalgam	saturated solution of copper sulphate	mercurous sulphate	mercury

and it was found that the e.m.f. of such cells is independent of the percentage of copper in the amalgam within the limits stated. In addition to the Daniell cell, others of the following forms were experimented with :—

mercury and mercurous sulphate	saturated solution of zinc sulphate	saturated solution of copper sulphate	mercury and mercurous sulphate

zinc	saturated solution of zinc sulphate	mercury and mercurous sulphate

copper	saturated solution of copper sulphate	mercury and mercurous sulphate

The e.m.f. and temperature variations of these cells were determined by comparison with a Weston cell, and it is shown that the Gibbs-Helmholtz equation holds good for the Daniell type. F. E. S.

2102. *Simultaneous Measurement of the Capacity and Power-factor of Condensers.* **F. W. Grover.** (Bureau of Standards, Bull. 8. pp. 871–481, Aug., 1907. Écl. Électr. 58. pp. 845–849, Dec. 7, 1907.)—Four bridge methods (one of them due to Wien) for obtaining simultaneously the ratio of two capacities and the difference of their power-factors are described. Various sources of error and the requisite methods for eliminating them are discussed. By the use of an auxiliary condenser, two condensers may be compared by substitution. This procedure has the advantage that electrostatic effects are eliminated, and only the relative values of the resistances and inductances of the bridge arms need to be determined accurately. Experimental results obtained by the four methods are in excellent agreement. When used as substitution methods the ratios of the capacities of condensers greater than 0·1 mfd. can be determined with a maximum inaccuracy of only two or three in 100,000. A phase-difference also of only a few seconds of arc, due to a difference in the absorption, may be detected with certainty. The small temperature-coefficients of good mica condensers can be readily found. By the use of a variable air condenser, trustworthy comparisons of the capacities and the power-factors of condensers of 0·001 mfd. or less, such as short lengths of cable, may be made easily. Methods are given by which the power-factor of the condensers to be used as standards may be measured. The Bureau of Standards is prepared to make such determinations. For good mica condensers θ (where $\sin\theta$ is the power-factor) lies between $0' 80''$ and $5'$. Figures are given to show how mica condensers even when made by well-known makers are sometimes very bad. The power-factor gives trustworthy information as to the order of magnitude of the absorption effects. The determination of the power-factor is the best single test of the quality of a condenser that can be made. Experiments are being made at the Bureau of Standards on the change of the capacity and the power-factor with changes of temperature and frequency. A. R.

2103. *Differential Method for Measurement of Small Resistances.* **H. Hausrath.** (Sammlung Elektrotechn. Vorträge, vol. 7, No. 12.) Discussion by **Schöne** (Elektrotechn. Zeitschr. 28. p. 1019, Oct. 17, 1907.)—The differential method of H. Hausrath is an extension of the Kohlrausch process, but instead of having a comparison resistance, a combination consisting of a slide wire shunted by a low resistance is employed. To exclude errors which are usually produced by the unequal magnitudes of the connection resistances, and those caused by unequal action of the current in the differential system, Hausrath gives a special method of measurement, the "double comparison." In comparing the differential method with that of Thomson [double-bridge], it is stated that the modified differential method allows of measurements free from error due to contact-resistances, and does not require a knowledge of the value of bridge coils as in the Thomson method. In the latter case the contact-resistances must not exceed a certain magnitude, and the sets of resistances must be accurately adjusted. In the *discussion*, it is pointed out that the introduction of a slide wire imposes limits on the accuracy of the modified differential method, and that the method requires more consideration before giving it the preference over the Thomson double-bridge. F. E. S.

2104. *Measurement of Mutual Inductance.* **A. Campbell.** (Phil. Mag. 14. pp. 494–508, Oct., 1907. Paper read before the Physical Soc., May 24, 1907. Electrician, 60. pp. 60–61, Oct. 25, 1907. Abstract.)—Methods of measuring mutual inductance by the aid of a vibration galvanometer are discussed. In order to make measurements with facility it was found necessary to put a resistance in series with the condenser in Carey Foster's arrangement of apparatus for comparing mutual inductance with capacity. The author's galvanometer consists of an electromagnet with a narrow air-gap in which is suspended a very light and small coil with bifilar control. The tension of the suspending filaments can be regulated by means of a spring. The range of the frequency obtainable depends on the moment of inertia of the moving part, the tension, the distance between the suspending filaments, &c. In one type it can be varied from 50 to 800. The control torque is usually strong, the tension being of the order of about 1 kg. The galvanometer can be usefully applied in connection with the Hughes' inductance bridge for comparing a self with a mutual inductance. The advantage of using a tuned galvanometer is that it largely obviates the necessity of obtaining a pure sine current. In conclusion, the author gives experimental results illustrating the high degree of accuracy obtainable by the modified Carey Foster method. A. R.

2105. *Induction Variometer and Resistance Combinations.* **H. Hausrath.** (Zeitschr. Instrumentenk. 27. pp. 302–312, Oct., 1907. Electrician, 60. pp. 331–332, Dec. 13, 1907.)—Two variometers were constructed, the one being very similar to the Wien type and having a range from 0·885 to 144·2 millihenrys, and the other consisting of fixed coils with a movable system sliding over and parallel to them. The range of the latter variometer is from

0·025 to 1·520 millihenrys, and the ranges pertaining to the various sections of both variometers are shown in the following tables :—

Variometer No. 1 (Wien Type).	*Variometer No. 2.*
0·885 to 1·606 millihenrys	0·025 to 0·037 millihenry
1·707 „ 4·128 „	0·038 „ 0·052 „
4·10 „ 15·50 „	0·050 „ 0·080 „
15·45 „ 36·61 „	0·081 „ 0·185 „
33·10 „ 54·88 „	0·181 „ 0·219 „
44·48 „ 78·68 „	0·220 „ 0·378 „
67·75 „ 108·1 „	0·372 „ 0·645 „
97·87 „ 144·2 „	0·560 „ 0·957 „
	0·852 „ 1·520 „

There is also described a combination of resistances by means of which small resistances can be accurately regulated. F. E. S.

2106. *Resistance Coils and Comparisons.* **C. V. Drysdale.** (Electrician, 59. pp. 955–957, Sept. 27 ; 989–991, Oct. 4 ; 1035–1037, Oct. 11 ; 60. pp. 20–21, Oct. 18, and pp. 53–55, Oct. 25, 1907. Paper read before the British Assoc. at Leicester.)—The author gives a survey of resistance coils showing their evolution from the B.A. pattern (1865) up to the present time. The properties of resistance alloys are briefly considered, and a table is given of the electrical properties of some of them. From observations made by the author it appears that manganin coils when properly protected are the most constant in resistance. For an ideal resistance standard an open-wound coil of an incorrodible or suitably protected alloy is suggested. The alloy should have as low a temperature variation as possible, while thermo-forces must be kept down, either by selecting a material of low thermal force against copper, or by making provision for keeping both junctions at the same temperature. To secure a very small temperature variation the author electroplated a wire having a negative temperature-coefficient of 0·0029 per cent., and obtained very good compensation when the alloy was nickel-plated. In a section dealing with standardising bridges the theory of a generalised slide wire bridge is given. In this bridge a slide wire connects the two ratio coils, and a second wire, in series with two resistance coils, shunts the two connected leads of the resistances to be compared. The arrangement is therefore a Kelvin double-bridge, and it can be so operated that the correction due to the shunted resistance is negligibly small. With ratio coils of 10 ohms the probable bridge error is stated to be not greater than one part in 10,000,000. F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

2107. *Propagation of Magnetisation.* **L. Donati.** (Elettricista, Rome, 6. pp. 241–248, Sept. 1, 1907.)—A thick cylindrical bundle of iron wire, 50 sq. cm. in sectional area and 8 m. long, is surrounded at one end over a length of 10 cm. by a magnetising coil of 400 turns fed by a central supply three-phase current. From the lag of phase at various points along the core the author calculates the velocity of the "wave of magnetisation" along the wires, and finds it to be of the order of 1,000 m. per sec. E. E. F.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

2108. *Conservation of the Human Arterial Pressure after Application of High-frequency Currents by Auto-conduction.* **J. Bergonié, A. Broca,** and **G. Ferrié.** (Comptes Rendus, 145. pp. 526–528, Sept. 16, 1907. Archives d'Él. Médicale, 15. pp. 781–785, Oct. 10, 1907.)—The experiments were made with a 10-kw. wireless telegraph plant from which effective (r.m.s.) currents of 15–20 amps. at a frequency of 400,000 per sec. were obtainable, currents nearly ten times greater than had hitherto been employed for this purpose. Using an output of 5 kw. and a max. p.d. at the terminals of the auto-conduction solenoid of 100,000 volts (15 cm. spark) and 10–15 wave-trains per sec., the max. intensity of each wave-train being about 500 amps., it was found that of 39 concordant measures 3 were indecisive, 4 gave a reduction, 10 an elevation, and 21 no variation of pressure. It is thus concluded that no change in pressure is produced. L. H. W.

REFERENCES.

2109. *Cohn's Electrodynamics.* **M. Laue.** (Ann. d. Physik, 23. 5. pp. 991–998, Sept. 24, 1907.)—Refers to an extension of the above system by Gans [see Abstract No. 1257 (1906)], and concludes that on the basis of Cohn's system an electrodynamics of the electrons can be built only for the case of motion in longitudinal electric and magnetic fields. E. H. B.

2110. *Resistance of Electrolytes in the Magnetic Field.* **G. Berndt.** (Ann. d. Physik, 23. 5. pp. 932–950, Sept. 24, 1907. Phys. Laborat. des Polytechnikums, Cöthen, July, 1907.)—The full paper corresponding to Abstract No. 1397 (1907).

2111. *Action of Torsion on Magnetisation.* **C. Maurain.** (Journ. de Physique, 6. pp. 380–388, May, 1907.)—A discussion of the results of Sella, of Piola and Tieri, and of Bouasse and Berthier, based on the "normal curve of magnetisation." L. H. W.

2112. *Radiation in Strong Electromagnetic Fields.* **G. Jaumann.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 389–508, March, 1907.)—This highly analytical paper in continuation of previous ones dealing with moving media [see Abstracts Nos. 1291 and 2058 (1906)] treats the following topics: (1) Principle of energy and energy flux. (2) Energy flux in heat conduction, Peltier- and Thomson-effects. (3) Radiation in strong electromagnetic fields. (4) Longitudinal rays in strong fields and high vacua. (5) Propagation, damping, and luminescence of kathode rays. (6) Their energy content and mechanical action. (7) Transverse vibrations at the boundary of longitudinal rays. (8) Charging effect of electric longitudinal rays. (9) Their heating effect. (10) Electrostatic deflection of kathode and canal rays. (11) Longitudinal rays in strong magnetic fields. (12) Magnetic deflection of kathode, anode, and canal rays. (13) Rays in solid and liquid insulators. (14) Electric double-refraction in uniform electric fields. (15) Magnetic rotation of plane of polarisation of light and (16) Rotatory dispersion. (17) Dichroism of circular polarisation in absorbing media. (18) The Zeeman-effect. (19) Electric convection of light. E. H. B.

2113. *Application of the Wilson-effect.* **L. Baumgardt.** (Ann. d. Physik, 23. 5. pp. 986–988, Sept. 24, 1907.)—Discusses the possibility of applying the Wilson-effect to the solution of the problem as to whether any e.m.f. or electric charge follows from the rotation of a cylindrical magnet about its axis. E. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2114. *Absorption of the Odours of Musk, Ionone, and Skatol by Surfaces of different Material.* **H. Zwaardemaker.** (Konink. Akad. Wetensch. Amsterdam, Versl. 16. pp. 81–85, June 5, and pp. 139–141, July 17, 1907. Proc., 10. pp. 116 and 120–122, Sept. 8, 1907.)—Experiments made by passing air saturated with the odours of musk, ionone, and skatol through tubes of various materials, at different temperatures, and noting the time that the odour is retained, show that whilst exposure at a higher temperature does not much shorten the time required for saturation, it considerably reduces the amount absorbed. The absorption by different materials is very irregular; thus Pb alloyed with Sn retains the odour of musk for 5 days, of ionone for scarcely a day, and of skatol for 5 days; steel does not take up musk at all, but preserves the odour of ionone for about 4 days, and of skatol for 10–18 days; Al retains musk for less than 1 day, ionone for 2¼ days, and skatol for 10 days. Porous porcelain and arc-lamp carbon scarcely absorb any ionone or skatol, and silver and glass absorb no appreciable ionone, and only sufficient skatol to persist for a few hours. These deviations are attributed to either a peculiar modification of the solubility caused by solution of the specific metallic particles in the condensation layer, or an absorption in the metal itself.

W. H. Sı.

2115. *Formation and Change of Glasses containing Water.* **F. Mylius and E. Groschuff.** (Zeitschr. Anorg. Chem. 55. 2. pp. 101–118, Aug. 27, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—Dilute sulphuric acid does not attack resistance glass appreciably, even after a very long time, and the absorption of water by the glass is slight. Inferior glass is attacked by dilute sulphuric acid at ordinary temperature, alkali being displaced by water to the extent of 12 per cent. without the glass losing its consistency. Even after the acid has been in contact with the glass for a year, the layer attacked still consists of hydrated glass poor in alkali and not of pure silicic acid. Heating increases the extent to which acid attacks glass. Gradual heating of hydrated glass causes a disaggregation of its substance accompanied by a diminution in volume. Rapid heating causes devitrification (*a*) by formation of foam, and (*b*) by the separation of solid substances within the glass; the devitrification is caused by loss of water. Devitrification requires a temperature of about 400°, and when accompanied by the separation of a solid phase—presumably silicic acid—takes place preferably in the layers rich in this acid. This separation of solid does not always take place in cases where loss of water proceeds gradually at lower temperatures. No devitrification is observed in hydrated glass when this is exposed to the action of aqueous acid for fifteen years at the ordinary temperature. T. H. P.

2116. *Occlusion and Diffusion of Gases in Metals.* **A. Sieverts.** (Zeitschr. Phys. Chem. 60. pp. 129–201, Aug. 6, 1907. Communication from the Laborat. f. angew. Chemie d. Univ., Leipzig.)—Copper begins to absorb hydrogen at 400°; at 640° diffusion through the metal can be detected. Iron showed a certain discrepancy between different samples. Diffusion and occlusion of hydrogen begin at 400°. Nitrogen is slowly absorbed above

900°, but at 500° in a vacuum is still not liberated again; even at 1,000° no definite diffusion could be detected. A sample of reduced iron absorbed nitrogen at 900°, but liberated it on cooling. The property is probably one belonging to γ-iron only. Nickel absorbs hydrogen below 200°; diffusion can be detected from 450° upwards. The occlusion of hydrogen and oxygen by Ag is very irregular; up to 640° neither gas diffuses through the metal. The diffusion of hydrogen through Pt is measurable at 576°. Oxygen and other gases do not diffuse. The occlusion of hydrogen by Pt is very slight; with oxygen, combination may play a part. Diffusion and occlusion do not appear to be closely related to one another; diffusion may be rapid with very small occlusion, as in Pt, or the converse may be the case as in Ni and Cu at low temperatures. In all cases the velocity of diffusion increases with the temperature; in Cu, Fe, Ni, and Co the solubility also increases, but the opposite is the case with Pd. The activity—as a reducing agent—of hydrogen in presence of Ni is attributed to occlusion rather than to the formation of definite hydrides.

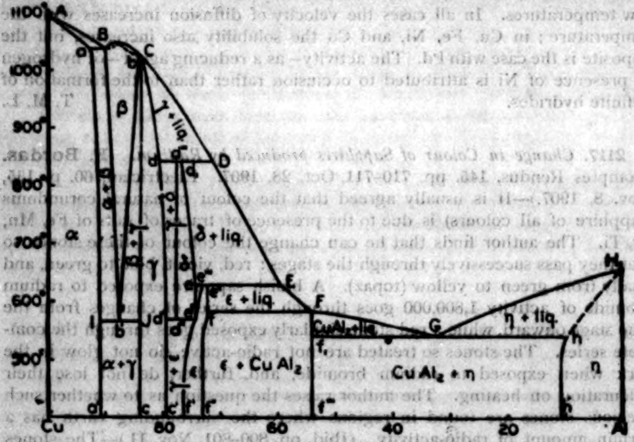
T. M. L.

2117. *Change in Colour of Sapphires produced by Radium.* **F. Bordas.** (Comptes Rendus, 145. pp. 710–711, Oct. 28, 1907. Electrician, 60. p. 185, Nov. 8, 1907.)—It is usually agreed that the colour of natural corundums (sapphire of all colours) is due to the presence of traces of salts of Fe, Mn, Cr, Ti. The author finds that he can change the colour of these stones so that they pass successively through the stages: red, violet, blue to green, and finally from green to yellow (topaz). A bluish sapphire exposed to radium bromide of activity 1,800,000 goes through the series of changes from the blue stage onward, while a red stone similarly exposed goes through the complete series. The stones so treated are not radio-active, do not glow in the dark when exposed to radium bromide, and, further, do not lose their colouration on heating. The author raises the question as to whether such precious stones are found in regions where the surrounding earth has a certain amount of radio-activity. (Ibid. pp. 800–801, Nov. 11.)—The stones can be exposed in direct contact with the tube of radium bromide, and in daylight. The position should be shifted every few hours to obtain uniform results. The desired change of colour is produced in a few days. Colourless corundum has been changed into topaz, the colour of natural topaz improved, and the colour of pale rubies enhanced by the same means. The emanation has no action. Alumina drops (artificial rubies), containing only minute traces of Cr and which were almost colourless, are also found to colour in the same sequence of changes. The method is thus available for detecting traces of metals. It is considered that the process can hardly be an oxidation since the effect is also obtained when the stone and radium are plunged in liquid nitrogen (at −200° C.). (Ibid. pp. 874–875, Nov. 18.)—The effect cannot be due to the α-rays, since the radium was sealed in glass. Röntgen rays are, however, found to produce a similar colouration, and hence it is concluded that it is the γ-rays which cause the effect.

L. H. W.

2118. *Copper-Aluminium Alloys—Constitution.* **B. E. Curry.** —*Tensile Strength.* **B. E. Curry** and **S. H. Woods.** (Journ. Phys. Chem. 11. pp. 425–436 and 461–491, June, 1907.)—The equilibrium diagram for the Cu-Al alloys above 400° is given below, the results being mainly founded upon *heating*-curves of the alloys. Only one compound, $CuAl_2$, is recognised.

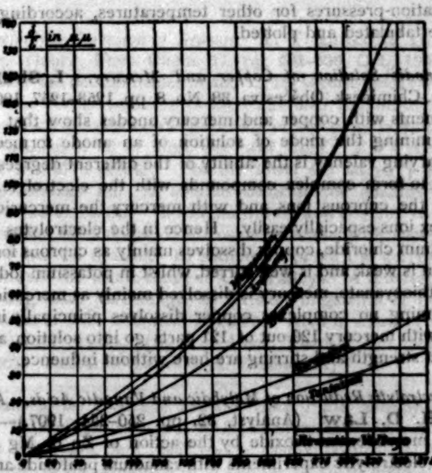
There are six series of solid solutions. There are two thermal changes below the solidus; the β and δ phases being unstable below 566° and 570° respectively. The tensile tests were made upon samples as cast, or cast and heat treated in accordance with the diagram, but not forged. At the Al-rich end the best alloy contains 10 per cent. Cu and has 28,000 lbs. per sq. in. tensile strength. The tensile strength of the Al-rich series is reduced, and the elongation increased, by annealing from 3 to 6 days at 400°. With 90 per cent. Cu, the chill-cast alloys, or castings annealed above 566° give 100,000 lbs. per sq. in. tensile strength. This is reduced by annealing below 566°. With more than 92 per cent. Cu, annealing has little effect on strength or ductility.



Generally, annealing of the Cu-rich alloys decreases the ductility. Incidentally it was observed that upon adding Al to molten Cu the temperature rises from 150° to 250°. That this is not due to the reduction of copper oxide is indicated by the fact that upon adding more Al there is a similar rise in temperature. The evolution is therefore heat of solution. [See also Abstract No. 1711 (1907).] F. R.

2119. *Zinc-Cadmium Alloys.* **G. Hindrichs.** (Zeitschr. Anorg. Chem. 56. 4. pp. 415–418, Oct. 12, 1907. Metallographic Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Describes the study of the alloys by thermal and microscopic methods. Both indicate the presence of eutectic in the 1 per cent. Cd, and 1 per cent. Zn alloys. Microscopic examination of the rapidly cooled 1 per cent. alloys, obtained by pouring the molten alloys into a thin sheet-metal mould standing in a freezing mixture at −18° C., clearly shows the presence of eutectic. The author concludes that the metals crystallise out in the pure state, and that it is impossible to obtain supersaturated solid solutions of a concentration greater than 1 per cent. Cd or 1 per cent. Zn by quenching the molten alloy. The series forms a rare example of two metals, perfectly miscible in the liquid state, which form neither solid solutions nor compounds. F. C. A. H. L.

2120. *Electrolytic Valve Action of Magnesium, Antimony, and Bismuth.* **G. Schulze.** (Ann. d. Physik, 24. 1. pp. 48–54, Oct. 8, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The author has extended his research [Abstracts Nos. 924, 1260 (1907)] so as to include the metals Cr, Sn, Bi, Sb, and Mg. No valve effect proper was found in the case of Cr and Sn. The curve of thickness (δ) of the effective film as a function of the formation voltage (e), the dielectric constant (ϵ) being taken as unity, it is now proposed should be called the curve of "barring capability" (that is the capability of the film, at a definite capacity, to withstand a definite voltage). When the "barring capability" is very great, either the dielectric constant is high or the thickness of the film very small. The results of the investigation are given separately, with the curve, for each metal; these curves are grouped together in the Fig., for temperature 0° C. The author summarises his conclusions as follows: (1) Magnesium shows a "valve" effect besides in KOH and K_2CO_3, also in $NaHPO_4 + NH_3$, in which electrolyte up to 850 volts can be withstood. The sensitiveness to cutting off of the current is small in KOH and K_2CO_3, but that to heat is very great. (2) Antimony shows a valve effect in almost all electrolytes. The highest voltage withstood was over 700 volts in very dilute KCl. The sensitiveness to heat is less than with Mg, but that to rupture of the current very great. (3) Bismuth also shows a valve effect in almost all electrolytes. The highest voltage is reached in very dilute KOH (viz., 600 volts). The sensitiveness to either heating or rupture of the current is small; hence the author considers Bi of value for electrolytic rectifiers. (4) The curve of "barring capability" has a different position for each of the metals examined. The previous explanation of the effect as being due to a gas layer in the pores of the solid skin should be modified so as to show that the solid skin internal to the effective layer always consists of the oxide of the anode metal, and only changes into the ordinary solid skin (compound of the metal with the anion of the electrolyte) on quitting the effective layer. L. H. W.



2121. *Dissociation of Oxides.* **W. Stahl.** (Metallurgie, 4. pp. 682–690, Oct. 22, 1907.)—Some of the data on which the following table of the dissociation-temperatures of oxides at atmospheric pressure are founded are derived from the author's experiments:—

Reaction.	Absolute Temperature.
$2Ag_2O = 2Ag_2 + O_2$	888°
$4CuO = 2Cu_2O + O_2$	1,679
$2Cu_2O = 2Cu_2 + O_2$	1,985
$2CuO = Cu_2 + O_2$	1,775/1,886 (Joannis)
$2PbO = Pb_2 + O_2$	2,348
$2NiO = Ni_2 + O_2$	2,751
$2ZnO = Zn_2 + O_2$	3,817

The dissociation-pressures for other temperatures, according to Nernst's formula, are tabulated and plotted. F. R.

2122. *Anodic Solution of Copper and Mercury.* **I. Shukoff.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 38. No. 8. pp. 1253–1257, 1906.)—Electrolytic experiments with copper and mercury anodes show that the principal factor determining the mode of solution of an anode formed of a metal exhibiting varying valency is the ability of the different degrees of oxidation of the metal to form complex compounds with the electrolyte. Thus with copper it is the cuprous ions, and with mercury the mercuric ions, which form complex ions especially easily. Hence in the electrolytes hydrochloric acid and sodium chloride, copper dissolves mainly as cuprous ions, especially if the solution is weak and is well stirred, whilst in potassium iodide, chloride, bromide, or thiocyanate, mercury is dissolved mainly as mercuric ions. With solutions forming no complexes copper dissolves principally in the cupric state, while with mercury 120 out of 121 parts go into solution as mercurous ions; current strength and stirring are here without influence. T. H. P.

2123. *Electrolytic Reduction of Molybdic and Vanadic Acids.* **A. C. Chapman** and **H. D. Law.** (Analyst, 32. pp. 250–254, 1907.)—Besides the reduction of molybdenum trioxide by the action of Zn or Mg in H_2SO_4 or HCl solution, electrolytic experiments with vanadium pentoxide are described. These latter show that when a platinised Pt kathode is used the reduction does not proceed as far as the trioxide stage even; with Zn, Cd, or Pb it approaches the dioxide stage, the lowest point possible. L. H. W.

2124. *Electrolytic Deposition of Nickel.* **A. Brochet.** (Comptes Rendus, 145. pp. 627–628, Oct. 14, 1907. Ind. Élect. 16. p. 524, Nov. 25, 1907.)—Electrolysis of nickel salts by themselves gives bad results, hydrated nickel oxide being deposited on the kathode when the chloride is used, while with the sulphate sulphuric acid is set free and oxygen evolved. The difficulty with the former may be overcome by adding boric acid to the electrolyte, thus preventing the injurious effect of nickel hydrate upon the whiteness of the deposit, and in the case of sulphate the presence of an ammonium or other alkaline salt is necessary for satisfactory deposition of the metal. Nickel anodes are peculiar in becoming pitted at a number of points, holes being soon formed, whilst in other parts the original thickness of the plates is preserved. W. H. St.

2125. *Kathodic Precipitation of Carbon.* **W. Blum** and **E. F. Smith.** (Amer. Phil. Soc., Proc. 46. pp. 59–62, Jan.–March, 1907. Contribution from the John Harrison Lab. of Chemistry. Chem. News, 96. pp. 200–201, Oct. 25, 1907.)—Carbon is deposited on the kathode from solutions containing tartaric, citric, lactic, or benzoic acids. This is especially the case if a stationary anode be used together with a high current-density. When a high current-density is used platinum also dissolves from the anode and is deposited on the kathode. No black deposit is obtained from solutions of ammonium oxalate, formate, acetate, or succinate. According to the authors, the acids which give black deposits are broken down at the anode, and the carbon thus liberated forms a hydrate in solution. The carbon is deposited from this hydrate at the kathode. Consequently, when iron is deposited from a citrate or tartrate solution both iron and carbon ions are deposited simultaneously at the kathode, giving an alloy (carbide) of iron and carbon.

T. S. P.

2126. *Electrolytic Corrosion of Brasses.* **A. T. Lincoln, D. Klein, and P. E. Howe.** (Journ. Phys. Chem. 11. pp. 501–536, Oct., 1907.)—Copper-zinc alloys which had been annealed at 400° C. for several weeks were corroded electrolytically in normal solutions of the commoner sodium and ammonium salts. The product of corrosion is generally of the same composition as the test piece for brasses of 50 or more per cent. Cu, *i.e.*, α, $\alpha + \beta$, and β alloys [see Abstract No. 2774 (1904)]. For the lower Cu alloys ($\gamma + \epsilon$, $\epsilon + \eta$) the product is practically Zn. In sodium chloride the amount of corrosion decreases with increased Cu. In sodium nitrate and acetate, and ammonium nitrate and oxalate, the amount of corrosion increases with decrease of Cu in high and very low Cu brasses. In sodium sulphate the corrosion is practically constant over the whole range of Cu-Zn alloys. A few results on Cu-Zn alloys containing small percentages of Sn were in general of the same kind as in the absence of Sn. Chemical corrosions tried in a few of the solutions gave unsatisfactory results. [Also in Amer. Electrochem. Soc., Trans. 11. pp. 43–80, 1907. Research Award to A. T. Lincoln.] F. R.

2127. *Study of the Causes of Impure Nickel Plate, with Special Reference to the Iron.* **D. F. Calhane and A. L. Gammage.** (Amer. Chem. Soc., Journ. 29. pp. 1268–1274, Sept., 1907.)—The rusting of nickel plate due to prolonged exposure to the atmosphere is caused by small amounts of Fe contained in the plate, which constitute with the Ni a series of galvanic couples. As commercially practised an anode of Ni and Fe is suspended in a bath of nickel ammonium sulphate. Iron is deposited in ordinary working with the Ni. Analysis of deposits on Pt from portions of old anodes showed the presence of 0·096 and 0·080 per cent. Fe. Further experiments demonstrated that, with stationary kathodes, stirring the electrolyte had practically no effect on current efficiency, but caused an increase in the Fe in the deposit from 0·18 per cent. for a *still* solution to 0·86 per cent. for the agitated solution, showing large amounts of mechanical occlusion. Rotation of the kathode at 180 r.p.m. reduced the current efficiency to about 1/6 of that obtained with a stationary kathode, and the percentages of Fe were 0·11 and 0·10 for the still, and 0·54 and 0·56 for the rotating kathode. Clouding of the solution led to surrounding the anodes with canvas bags, but on the kathode rotating at 260 r.p.m. the percentage of Fe in the deposit was now 0·75 to 0·80, whilst the deposit on the still kathode yielded 0·05 to 0·07 per cent. of Fe. The deposits on the still kathodes dissolved with difficulty in HCl, but those on the rotated kathodes were often dark-coloured and dissolved readily. Higher speeds of rotation with spiral kathodes, both with and without bags for the anodes, were also tried. The results show that at least 0·07 per cent. of Fe comes by primary deposition, and that the faster the kathodes are rotated the less is the current efficiency in Ni. To ascertain if current deficiencies were due to peeling off of Ni from the rotating kathodes, these were placed in porous jars, and the results showed that deficiencies were not so caused. *General Conclusions.*—Stirring the electrolyte or rotation of electrodes increases the amount of iron impurity considerably. Surrounding the anodes with a suitable filtering medium reduces the amount of iron impurity about one-half. About 0·04 to 0·05 per cent. of Fe will appear in the nickel plate in spite of filtering septa, and is probably due to primary deposition, and consequently the avoidance of small amounts of iron in nickel plate does not seem possible with the anodes used at present in technical work. Further experiments with pure Ni anodes and an effective corroding electrolyte will be undertaken. W. P. D.

2128. *Electrolytic Reduction of Tungstic Acid.* **H. Leiser.** (Zeitschr. Elektrochem. 13, pp. 690–694, Oct. 25, 1907. Communication from the elektrochem. Laborat. d. Kgl. techn. Hochschule, Berlin.)—It is not possible to isolate the blue compound formed by the reduction of a normal tungstate in acid solution, but by starting with a solution of known composition, and using a Pt dish kathode and a Ni anode—whereby anodic oxidation of the liquid was prevented, the Ni simply dissolving—the author was able to find the composition of the blue compound by titration of the solution with potassium permanganate. The formula was found to be W_4O_{11}. According to the permanganate titrations lead kathodes did not reduce so well as kathodes of Pt, but measurement of the hydrogen evolved showed that the amount of hydrogen used up was greater with Pb than with Pt. The discrepancy was due to the formation of a dark deposit on the Pb, which deposit was shown to have probably the composition WO_2. T. S. P.

REFERENCES.

2129. *Microscopic Study of Strain in Metals.* **F. Rogers.** (Roy. Microscop. Soc., Journ. pp. 14–18, 1907.)—Discusses heat treatment after fatigue due to reversals of stress, with photomicrographs. L. H. W.

2130. *Action of Oxygen on Water Solutions.* **O. Mumm.** (Zeitschr. Phys. Chem. 59. pp. 459–491, June 11, 1907. Habilitationsschrift, Kiel.)—The author has made a very exhaustive examination of the action of oxygen upon water solutions; upon the reactions which take place during the electrolysis of water; and upon the hydrogen-oxygen cell. The paper is unsuitable for abstraction, and the original must be consulted for details. F. J. B.

2131. *Conductivity of Electrolytes in Pyridine and other Solvents.* **K. S. Caldwell.** (Chem. News, 96. pp. 75–76, Aug. 16, 1907. Paper read before the British Assoc. at Leicester.)—I. Comparison of Acids and Pseudo-acids in Pyridine. II. Influence of Temperature on Conductivity. III. Abnormally High Conductivities. [See Abstract No. 1731 (1907).] T. M. L.

2132. *The Fusion Curve of Binary Mixtures.* **D. Mazzotto.** (N. Cimento, 13. pp. 80–101, Jan., and Feb., 1907.)—A discussion of the case of tin amalgams. Not suitable for brief abstraction. D. H. J.